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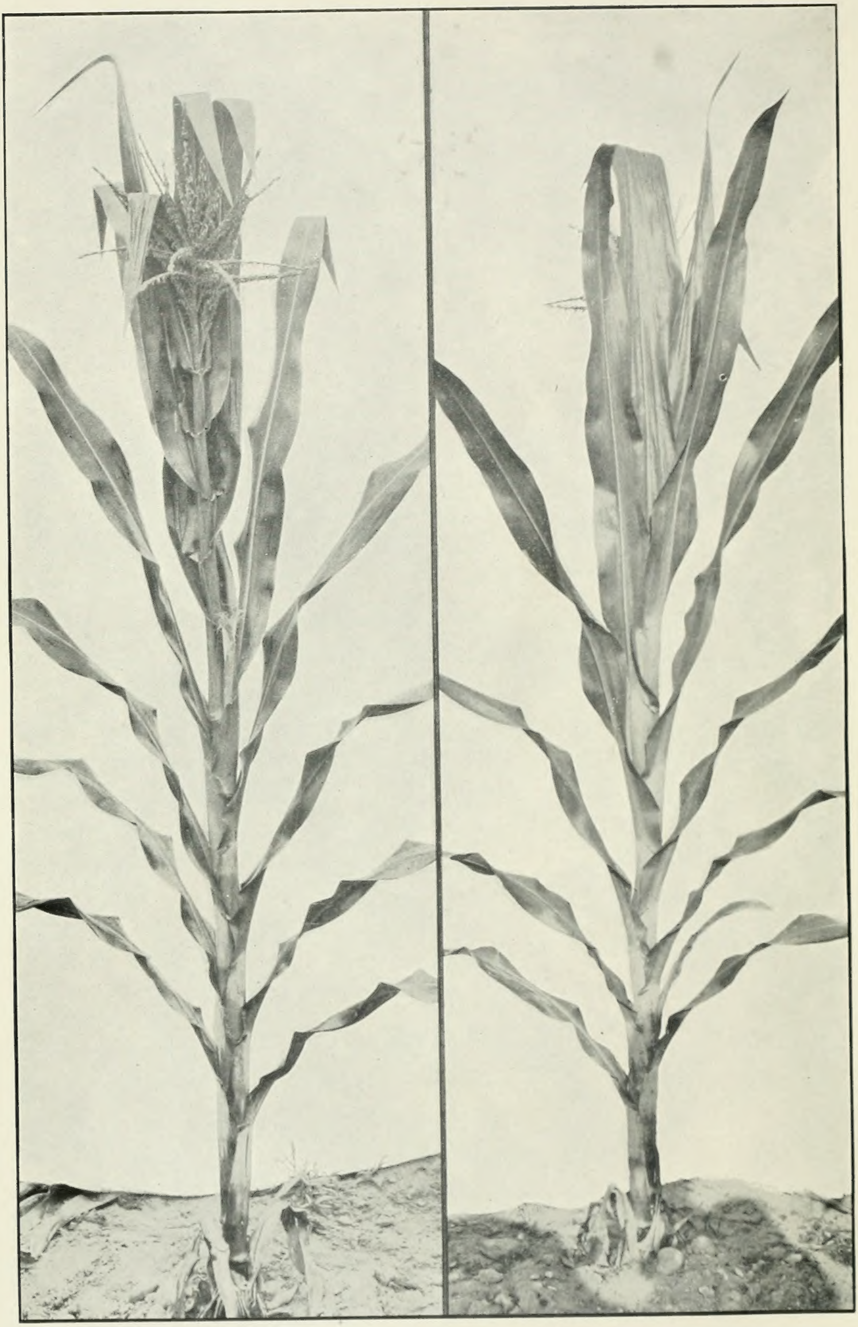

CHINESE MAIZE: FRONT AND BACK VIEW OF THE SAME PLANT.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 161. —170

B. T. GALLOWAY, *Chief of Bureau.*

U. S. Bureau of Plant Industry, Soils and Agricultural Engineering

A NEW TYPE OF INDIAN CORN FROM CHINA.

BY

G. N. COLLINS, ASSISTANT BOTANIST.

ISSUED DECEMBER 9, 1909. — March 1910

239486-95
13.1.30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909. —1910

SB
19
A35
no. 161-170

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 12, 1909.

Sir: I have the honor to transmit herewith a paper entitled "A New Type of Indian Corn from China," by Mr. G. N. Collins, Assistant Botanist of this Bureau, and recommend its publication as Bulletin No. 161 of the Bureau series.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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A NEW TYPE OF INDIAN CORN FROM CHINA.

INTRODUCTION.

In March, 1908, a small sample of shelled corn was received by the Office of Foreign Seed and Plant Introduction from Rev. J. M. W. Farnham, of the American Presbyterian Mission at Shanghai, China, with the following note:

> A peculiar kind of corn. There are several colors, but they are said to be all the same variety. The corn is much more glutinous than other varieties, so far as I know, and may be found to be of some use, perhaps as porridge.

Plants were grown from this seed in the season of 1908 and proved to be quite unlike any of our cultivated varieties or those known from Tropical America. They possessed a number of unique characters, no indication of which is found in any of the forms of *Zea mays* thus far recorded. Since this new type of maize thus extends the range of diversity of the species and enhances the possibilities of breeding by providing additional characters and adaptations, it appears desirable to place on record a description of the variety, with an enumeration of its peculiarities. Several of the unique features combine to enable the plant to resist the drying out of the silks by dry, hot winds at the time of flowering.

Although the plants and the ears they produce are so small that the variety would probably find no place in direct competition with our improved varieties, the possession of this adaptation gives the new type an economic interest, particularly in some parts of the semiarid Southwest. In these regions a hot desert wind at the time of flowering will dry the silks before the grains have been pollinated, and often causes a complete failure of the crop, even under conditions not otherwise unfavorable. This danger would be greatly reduced if our varieties had some of the habits of this Chinese corn, and the effort is now being made to combine, by hybridizing, the desirable characters of this small variety with those of larger and more productive types.

Another noteworthy feature of this corn is the character of the endosperm, which is quite distinct from the horny, starchy, or sweet endosperms of the varieties hitherto known in the United States. In view of the recent development of specialized corn products as human food, this unique type of starch may be of some economic importance.

DESCRIPTION OF VARIETY.

The seed of this corn as originally received from China was a mixture of yellow, white, and red grains, many of the latter being more or less mottled. Separate plantings were made of the yellow, white, and red colors and of the mottled grains. No differences in the behavior of the different plantings were detected, and the following description applies to the whole series.

The seed was planted near Washington, D. C., on May 9, 1908, and 53 plants were grown to maturity. The first pollen was shed eighty-two days after planting and the seed was harvested one hundred and thirty-nine days from planting, at which date most of the seed had been mature for some time. As a rule the silks appeared on the individual plants at about the time that the last of the pollen was being shed. One stalk was noted with silks at two ears, while the plant was still producing pollen. Suckers were produced by 40 per cent of the plants.

The plants were of small stature, ranging from 3½ to 6 feet in height; the average circumference of the stalk at the smallest point of the largest internode was slightly less than 3 inches. The number of nodes above the ground ranged from 11 to 15, with 4 nodes above the ear. The average number of green leaves at the time of tasseling was 12. The blade of the fifth leaf from the top averaged 31½ inches long by 3⅓ inches wide. The longest leaf sheath averaged 7½ inches. The plants produced from 1 to 3 ears, a single ear at a node in every case. The ears were small and slightly tapering, averaging 5½ inches long by 4⅓ inches in greatest circumference, with 16 to 18 rows of small grains. Nothing unusual in the size or distribution of the roots could be observed.

Except for their short, stocky habit of growth the plants showed no unusual behavior until after the leaves of the last four or five nodes began to appear. These leaves were formed in rapid succession, with very short internodes, and it was then noticed that on a large proportion of the plants the blades of the leaves were all on one side of the main stem. Thus the upper part of the plant, instead of having the usual distichous or two-rowed arrangement of the leaf blades, might be described as having a one-rowed or monostichous arrangement. While in only about 25 per cent of the plants were the upper leaf blades completely monostichous, all of them showed a tendency in this direction. This one-ranked appearance is brought about by a twisting of the leaf sheaths, the actual insertion of the leaves being opposite, as in all grasses.

In addition to the unusual position of the leaves the blades of the upper nodes were erect instead of spreading or drooping, as in other varieties. The midrib of the blades did not form an angle with the sheathing base of the leaf, but continued upward in a straight line.

The internodes on the upper part of the plant were also much shortened, so that the tassel was not carried up, as in other varieties, but was considerably exceeded by the tips of the leaves.

The tassel was moderately compact, with from 14 to 30 primary branches, many of which were again branched. The spikelets were arranged in alternate groups of two, after the manner of most of our cultivated varieties. Nothing unusual was observed in the flowers. Pollen was produced in great abundance, and over a period of about five days in individual plants.

The following is a tabulation of the measurements of eighteen plants, the seed of which was hand-pollinated either in the production of hybrids or for the study of characters in pedigreed stock:

TABLE I.—*Measurements and details of growth of eighteen plants of Chinese corn.*

Designation of plant by number.	Days from planting to first pollen.	Days to first silks.	Green leaves.	Length of fifth leaf from top.	Width of fifth leaf from top.	Length of longest leaf sheath.	Primary branches in tassel.
	No.	*No.*	*No.*	*Cm.*	*Cm.*	*Cm.*	*No.*
1	....	....	9	63	7	15	14
2	....	99	12	74	7	....	16
3	97	....	13	67	8.5	17	....
4	....	....	10	85	9	22	20
5	81	85	11	81	8	17	16
6	82	86	13	84	9	19	24
7	86	93	13	88	8.5	22	30
8	....	....	11	85	9	20	....
9	....	94	14	88	9	20	18
10	105	....	10	70	6	20	....
11	96	100	13	83	9	18	26
12	....	....	12	75	8	17	....
13	....	....	9	96	7	21	19
14	92	106	13	88	10	21	20
15	102	....	13	83	9.5	19	28
16	86	89	13	78	9	19	18
17	94	98	12	86	9	21	....
18	....	....	12	75	8	17	17
Average	92.1	94.4	11.8	80.5	8.4	19.1	20.5

Designation of plant by number.	Height.	Circumference.	Internodes.	Ears.	Internodes above ear.	Length of ear stalk.	Suckers.	Layers of husks.
	Cm.	*Cm.*	*No.*	*No.*	*No.*	*Cm.*	*No.*	*No.*
1	117	5.5	11	1	4	....	1	....
2	142	8	....	2	4	11	0	....
3	142	7	13	....	4	7	1	5
4	184	7	15	1	4	8	0	....
5	120	6.5	11	1	4	10	....	7
6	130	9.5	13	3	4	18	1	....
7	170	9	13	2	4	17	2	....
8	....	....	12	....	4	....	1	....
9	176	10	15	2	5	10	2	6
10	....	6	14	1	5	6	....	....
11	167	8	14	2	4	8	0	7
12	145	8	13	2	5	....	....	....
13	180	6	14	1	4	7	....	6
14	180	9	15	2	6	8	....	....
15	189	8	14	2	....	16	0	6
16	162	8	13	2	4	10	0	5
17	160	8.5	13	....	4	8	1	7
18	145	8	13	2	5	....	....	....
Average	156.8	7.8	13.3	1.7	4.4	10.3	0.8	6.1

DISTINCTIVE CHARACTERS.

The following are the characters which distinguish this Chinese corn from our United States varieties as well as from any of the forms thus far observed in Tropical America. It should not be overlooked that the plants on which these observations were made were grown in an entirely new environment and that some of the characters exhibited may not be normal to the variety. Should this prove to be the case, however, these unique characters still show the possibilities of the species and are scarcely less interesting in the new connection.

Erect leaf blades.—The leaf blades of the upper nodes are in most cases erect, the midrib of the blade and the back of the leaf sheath forming a straight line. The leaves on the lower part of the plant are borne at the customary angle, but each succeeding leaf is slightly more erect than the preceding until they become completely erect on the last two or three nodes. Our common varieties exactly reverse this behavior, the blades that are somewhat erect being on the lower part of the plant, each succeeding blade being more nearly horizontal.

Our cultivated varieties vary greatly with respect to the angle of the blades, but nothing has been observed that approaches the definitely erect position of the blades in the Chinese variety. What at first appeared to be an approximation was seen in a type of corn from Colombia. A considerable series of varieties from different parts of that country, while not in the least resembling the Chinese corn in other particulars, had very erect leaf blades. The resemblance is, however, more apparent than real. The blades that are erect in the Colombian varieties are not those that immediately precede the tassel, but are several nodes lower down. Few of the Colombian varieties mature in the United States, and the uppermost leaves that are produced, though perhaps 20 feet from the ground, are still several nodes from the tassel. If the Colombian plants should reach maturity the blades that correspond to the erect blades of the Chinese variety would probably be borne much more nearly horizontal.

A much closer approximation to the erect blades of the Chinese variety was found in a single plant of a variety of dent corn secured from Brownsville, Tex. In this specimen the uppermost blade made an angle with the sheath of only 5°, although other plants of the same variety had the leaf blades borne at the customary angle. The plant with the upright leaves was also abnormal in other respects. In observing the range of this character the other extreme was found in drought-resistant varieties from the table-land of Mexico, which have the uppermost leaf blades bent away from the stalk at an angle of over 90°, or below the horizontal.

Monostichous arrangement of leaf blades.—The most striking peculiarity of this Chinese variety is the one-sided appearance of most of the plants, caused by having the leaf blades on the upper part of the plant all on one side of the stalk. This character is shown in Plate I, figures 1 and 2, which represent opposite sides of the same plant, and in Plate II, figure 2, a more detailed view of the upper part of a plant, showing the bases of the blades in their natural size and position.

This monostichous habit is definitely correlated with the erect position of the blades and follows almost as a necessary consequence. If the erect blades were arranged in the ordinary manner they would almost entirely inclose the silks and very greatly reduce the chances of pollination. The erect position of the blades, in connection with the monostichous habit, constitutes an almost ideal arrangement for insuring pollination. In the most extreme case the leaves of the fifth or sixth node from the base of the plant begin to show a deviation from the normal alternate arrangement, but in most cases only the last four or five leaves are distinctly on one side.

With the exception of the single abnormal plant in the Brownsville variety already mentioned, little tendency toward this monostichous habit was observed in any other variety, and the character seems never to have been recorded.

As a consequence of the monostichous habit the top of the plant is curved or scorpoid. The crowding of the leaf blades on one side of the plant necessarily displaces the top, so that it curves toward the open side of the plant. In the most pronounced cases the tip of the plant is curved to such an extent that the last leaves pass the perpendicular and bend forward over the tassel, with the back of the leaf uppermost.

Development of silks by ears while still inclosed in the leaf sheaths.—A third character associated with the erect blades and monostichous habit is the production of the silks directly at the junction of the leaf blade and sheath. This character, while by no means so rare as the two preceding, does not appear, so far as the writer knows, in any of the varieties of field corn now cultivated in the United States. It is brought about by the development of the silks at an early stage, before the ear stalk has elongated and while the young ear is very small. The silks appear at the base of the leaf, where it joins the sheath before there is any other indication of an ear, except a slight swelling of the leaf sheath.

A similar tendency to produce the silks before the young ear emerges from the leaf sheath is also shown by several entirely unrelated types from the American Tropics, but appears to be confined to varieties from regions that are subjected to severe drought.

Waxy endosperm.—The most distinctive character possessed by this Chinese variety is the nature of the endosperm, which is entirely unlike that of any of the known varieties of corn. A discussion of this character occurs on page 14, where the characters of the grain are described.

RESISTANCE TO DRY WINDS.

The combination of the three characters—erect leaf blades, monostichous arrangement of leaf blades, and silks borne directly in the angle where the blade joins the sheath—combine to constitute a most beautiful adaptation that prevents the drying out of the silks before pollination. The erect, overlapping blades catch all pollen that is blown against the upper part of the plant and allow it to settle in the channels at the base of the blades, where it accumulates in considerable quantities. The receptive silks are then pushed into this accumulation of pollen and can thus become fertilized before they are ever exposed to the air.

With our ordinary varieties of Indian corn the ear is usually pushed out a considerable distance, often from 6 inches to a foot above the base of the leaf, before the silks appear. The moist, receptive stigmas are thus fully exposed to the air, and if pollen is at all scarce it may be several days before the majority of the silks are pollinated. The delicate silks are very susceptible to injury from drought, but where pollen is produced over a considerable period no permanent injury may be done, for the silks that are not pollinated continue to grow and to produce new stigmatic surface for a week or more.

In the semiarid district of the Southwest this continued growth of the silks is often of no avail. If the production of pollen is held in check for a few days by cool, moist conditions the dry, hot weather which often follows abruptly brings all the pollen to maturity within a very few days and at a time when the silks are too dry to be pollinated.

Even where the silks are not destroyed by drought, pollination is often imperfect. Though the pollen is produced in great abundance,[a] it is so thoroughly scattered by the wind that the chances of each silk receiving its grain of pollen are by no means complete. In the Chinese corn, however, the pollen is literally collected and held in readiness so that each silk must come in contact with many grains.

This combination of characters, while constituting an effective adaptation against drought at the time of flowering, might have its disadvantages if moist conditions prevailed. The accumulation of pollen in the axils of the blades if kept moist would form an excellent medium for the development of molds, bacteria, and fungi.

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[a] Individual plants are estimated to produce from 10 to 70 millions of pollen grains. (See Lazenby, W. R., The Blossoming and Pollination of Indian Corn, Proceedings of the Meetings of the Society for the Promotion of Agricultural Science, vol. 13–16, 1896–1899, p. 127).

As the upright blades of the leaves always extend above the tassels it seems that the chances of self-pollination must be greater than usual, especially since in this Chinese variety the tassels do not appear much before the silks. The production of more than one ear on each stalk, which is usual in this variety, would to some extent correct the tendency to self-pollination, for in practically all cases the second ear must be cross-pollinated. In regions where high winds prevail at the time of flowering, the percentage of self-fertilized grains would be further reduced.

This adaptation would be still more perfect if the plants were oriented so that the open side of the plant was presented to a prevailing wind. In our experimental planting the plants appeared to face indifferently in all directions, but the number of plants was small and if any tendency toward a definite orientation existed the wind would doubtless be the exciting cause, while in the absence of a definitely prevailing wind such orientation could hardly be expected.[a]

CLIMATE OF THE REGION WHERE THE TYPE WAS DISCOVERED.

The climate of the vicinity of Shanghai where Doctor Farnham found this corn is not shown by the available meteorological data to be of the exacting nature which might be expected to call forth a special adaptation against drought. The characters of the plant do not indicate a general resistance to drought, but rather an adaptation against dry winds at the time of flowering. These periods of drought might be of such short duration that no indication of them would be given by ordinary meteorological data on rainfall and humidity. Short periods of drought do occur in many regions and have little effect on the total monthly rainfall and average humidity, but are nevertheless an important factor in determining plant growth. It is also not improbable that the variety here described was originally from the northern part of China, where extreme droughts during the summer months are the rule. If this is the case, the cultivation of this variety, even in China, must be somewhat restricted, for Mr. Frank N. Meyer says that nothing resembling this type was seen by him in the northern part of China, where he traveled for nearly three years, making a study of the agriculture of that region.[a]

DESCRIPTION OF GRAIN.

Color.—The original seed was very much mixed with respect to color. A majority of the grains had a yellow endosperm and a dull ruby-colored aleurone layer. Few were pure white and a still smaller number a very light lemon-yellow.

The color of the aleurone layer was distinct from anything that has been observed in other varieties. It varied greatly in intensity.

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[a] See note on page 25.

In rare cases it approached the bluish black of our common "black" varieties, but for the most part varied from a dull ruby to maroon. The color was usually confined to the top of the seed, fading out toward the base and sometimes slightly mottled. The pericarp was in all cases transparent.

The location of a red color in the aleurone layer is in itself a rather unusual character. As a rule in red varieties the color is located in the pericarp or outside coat of the seed. The aleurone, or the layer of cells immediately inside the seed coat, if colored, is usually some shade of blue, which may vary from slate color through purple to black. There is one well-known exception, the Voorhees red sweet corn, which has a dark-red aleurone. It is interesting to note that this variety originated by crossing a white variety (colorless aleurone layer) and one which had a blue-black aleurone.[a]

Size and shape of kernels.—Most of the seeds are cuneate with rounded tops, straight sides, and pointed bases, though there were many broader seeds with blunt bases. The cross section is circular or indistinctly hexagonal, the transverse diameter being only slightly greater than the longitudinal. In the form and size of the kernels, as well as in the appearance of the ear, this corn is very similar to a type commonly grown in southern and southeastern Europe.[b]

In the original seed the size was very variable, due largely to the presence of poorly formed grains. The white seeds were somewhat more uniform and slightly larger than those with red aleurone. The red seeds averaged 7 mm. long and 5.8 mm. in greatest width (50 seeds measured), while the same number of white seeds averaged 7.4 mm. long and 6.1 mm. wide. The average weight of the red seeds was 0.098 and of the white 0.122 gram.

New type of endosperm (*waxy endosperm*).—The texture of the endosperm is one of the unique features of this corn. There is a very small amount of the amylaceous or starchy endosperm, about as it appears in the common varieties of pop corn. The remainder of the endosperm occupying the position of the corneous or horny endosperm of our ordinary varieties is quite distinct in its appearance and mechanical characteristics, and must be considered as constituting another type of endosperm in addition to the amylaceous or starchy and the corneous or horny endosperm possessed by flint, dent, and soft varieties.

This new type of endosperm is undoubtedly more closely related to the corneous endosperm and occupies the same position in the grain, but its physical properties are strikingly different. It is less glassy than the corneous endosperm, though nearly as hard. Cut in any direction it separates with a sort of cleavage, exposing a dull, smooth surface. Instead of being translucent it is completely opaque, though not in the least approaching the coarse opaque texture of the amylaceous endosperm. The texture suggests that of the hardest waxes, though it is still harder and more crystalline. From this optical resemblance to wax the term cereous or waxy endosperm is suggested. Like the corneous endosperm it is either white or yellow, while the amylaceous endosperm, so far as observed, is always white. The opaque nature of this cereous endosperm is especially evident when grains with a colored aleurone layer are cut. When colored grains with a corneous endosperm are cut the translucent nature of the endosperm causes it to appear colored like the aleurone layer, while in the Chinese corn the endosperm appears in its true color, white or yellow, unaffected by the color of the aleurone.

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[a] Halsted and Kelsey. Bulletin 170, New Jersey Agricultural Experiment Station. 1904.

[b] Mr. J. D. Shanahan, of the Bureau of Plant Industry, states that these varieties with small grains command a special price in England, where they are in demand as a food for pheasants.

Composition of seed.—The appearance and physical composition of the seeds of this Chinese corn were so distinct from that of other varieties that the possibility of a difference in chemical composition naturally suggested itself, but analyses did not yield any very unusual results. Analyses of two ears, apparently similar, showed very different percentages of oil and protein, but all within the limits reported from analyses of American varieties.

With a view to ascertaining something of the range of composition in different types of corn a series of twenty-one varieties was analyzed and appears in the table below, arranged in order of the percentage of protein. The analyses were made by the Bureau of Chemistry of this Department from samples thoroughly air dried. The oil and protein are calculated on a water-free basis.

Table II.—*Chemical analyses of twenty-one varieties of Indian corn.*

No. of variety.	Class of corn.	Source.	Protein.	Oil.	Water.	Weight of 1,000 seeds.
			Per cent.	*Per cent.*	*Per cent.*	*Grams.*
1	Pop	Hungary	13.31	5.46	9.05	122
2	Soft	Hopi Indians, Arizona	12.49	6.87	9.48	254
3	do	do	12.10	7.58	10.08	
4	Flint	Argentine	11.84	5.66	8.95	241
5	do	Rhode Island	11.80	5.06	9.81	
6	Wax (new Chinese type)	China	11.80	6.12	10.11	
7	Dent	Colombia	11.63	4.23	9.63	493
8	Soft	Hopi Indians, Arizona	11.00	6.82	10.53	
9	Dent	Chiapas, Mexico	10.61	5.37	9.34	560
10	Soft	Tuscarora Indians, New York.	10.01	5.80	9.27	403
11	Flint	North Dakota	9.90	5.51	9.87	
12	Dent	Illinois	9.75	4.48	9.83	
13	do	do	9.65	4.60	9.80	
14	Soft	Hopi Indians, Arizona	9.50	6.20	9.67	
15	Chinese hybrid, corneous endosperm.	China	9.28	4.49	9.09	132
16	Pop	Algeria	9.19	5.98	8.25	121
17	Dent (shoe-peg)	Vera Cruz	8.74	6.39	10.52	349
18	Soft	Chihuahua, Mexico	8.46	5.64	9.31	336
19	Pop	Toluca, Mexico	8.35	6.36	10.06	81
20	Wax (new Chinese type)	China	8.26	4.12	9.01	98
21	Dent	Chihuahua, Mexico	8.05	4.98	8.67	190

Table II shows that the chemical composition of the seeds of corn stands in no direct relation to the type of grain. Similar varieties are widely separated with respect to amount of protein and oil, and such diverse types as the soft corns and the pop corns may show a closely similar chemical composition. Thus one variety of soft corn stands next to the top in percentage of protein and a similar variety is fourth from the last. One variety that must be classed as a pop corn heads the list, with 13.31 per cent of protein, while another variety of pop corn from Mexico is third from the last, with 8.35 per cent. It is further interesting to note that the variety of soft corn grown by the Hopi Indians stands first in percentage of oil, second in percentage of protein, and third in amount of water.

It has frequently been noted that the composition of different ears of a uniform strain shows diversities of the same order as that found in a series of varieties. Even the very distinct types included in the above series show only a slightly greater range than that usually found in a similar number of ears of a single uniform variety.

Crossing the Chinese corn with other varieties seems to have the effect of increasing the percentages both of oil and of protein in the same season that the cross is made. Seed from an open-pollinated ear that had received foreign pollen, as shown by the corneous nature of the endosperm, showed an increase of 1.02 per cent in oil and 0.37 per cent in protein over the pure seed from the same ear.[a]

XENIA.

During the season of 1908 a number of hand-pollinations inside the variety were made, and ten hybrids were also secured between the Chinese corn and other varieties. These ears afford an opportunity for preliminary observations regarding the behavior of hybrid characters that appear in the F_0 generation; that is, in the same year that the cross is made.

ALEURONE COLOR.

The red aleurone color appears in general to be prepotent when crossed with white varieties. A cross between two plants both from red seed produced an ear with 398 seeds, 312 showing the red color and 86 without, a ratio of 1:3.6+. Assuming that both plants were heterozygotes (i. e., crosses of red and colorless individuals) the expectation, according to Mendel's law, would be 1:3 or 298.5 and 99.5 ± 18.4. Another cross between a plant from a red seed and a white variety of starch corn from Chihuahua, Mexico, produced an ear with 431 seeds, 381 with colored aleurone and 50 without color; the expected ratio would be either all colored if the female were pure, or equal numbers of each if the female were heterozygote. Deviations from the expected ratio with respect to aleurone colors are common, but they are usually accompanied by gradations in the intensity of the color, while in this case the two classes were very sharply marked. Another cross between plants both from seeds with colored aleurone produced an ear with all the seeds red.

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[a] Scherffius reported no change in the protein content of hybrid seed compared with pure seed of the same ear; based on analyses of white seeds that appeared on open-pollinated ears of Reid yellow dent, Yellow Leaming, and Riley's Favorite. See Bulletin 122, Kentucky Agricultural Experiment Station, p. 188.

In a cross between a plant from a white seed of the Chinese (female) and a variety with black aleurone from Salvador the seeds all showed a mottling in the aleurone layer. None were pure black, though some were nearly pure white.

A cross between a starch variety grown by the Hopi Indians of Arizona with blue-black aleurone (female) and a white Chinese variety showed no trace of the white parent. This case is of particular interest, as the aleurone color in this Hopi variety is definitely recessive to colorless aleurone in the same variety.

Where plants from white seeds were pollinated among themselves, the result was in nearly every case a pure white ear. In six hand-pollinated ears among plants from seeds without aleurone color, four produced seeds entirely without aleurone color. The other two ears, while mostly white, produced in the one case 4 and in the other 6 seeds that showed aleurone color. Among the crosses with other varieties, 7 were between Chinese plants from white seed and other varieties without aleurone color; in every case the ears produced were entirely without aleurone color.

ENDOSPERM COLOR.

No crosses were made between Chinese plants from seeds with yellow and white endosperm, but from the appearance of the close-pollinated ears and those that were wind-pollinated it appears that the yellow is dominant, though varying in intensity, as with other varieties. All crosses between plants from seeds with white endosperm gave practically all white seeds, the exception being one poorly filled ear with 29 seeds, 4 of which had yellow endosperms. Since the same ear also showed seeds with horny endosperm, it seems not improbable that the precautions against foreign pollen were imperfect. Two crosses between plants from seed with yellow endosperms gave all yellow seeds.

ENDOSPERM TEXTURE.

The unique nature of the endosperm texture of this Chinese corn affords an interesting opportunity to study the behavior of definitely contrasted characters. So far as observed every grain of the original seed of the Chinese corn possessed the characteristic waxy endosperm, while nothing of this nature has been observed in any American variety. Since the waxy endosperm is completely recessive to the horny and starchy endosperm of our common varieties, its appearance in all the kernels of the original seed would indicate that the seed was grown in a region in China where there was no admixture with varieties having a horny endosperm.

Eight crosses were made between plants from seeds with waxy endosperms, and in practically every case the seeds were all waxy. Six ears produced from crosses between varieties with horny and waxy endosperms produced only horny kernels; two between starchy and waxy varieties had starchy kernels only.

SIZE OF SEED.

It was apparent from open-pollinated ears of Chinese corn that the size of the seed was influenced by the nature of the pollen. Seeds which showed by their color and texture the effect of foreign pollen were in nearly every case distinctly larger than those showing pure Chinese characteristics. Twenty-one yellow, transparent seeds from the central portion of an open-pollinated ear of white Chinese had an average weight of 0.178 gram, while the white opaque seeds from the same portion of the ear averaged 0.153 gram to the seed. There was some variation in the size of the white seed, but 21 of the largest of these averaged only 0.161 gram.

Further experiments are needed to determine whether this increase in size is due to the inheritance of the size of a large-seeded male parent or whether the increase is another instance of the increased size of a hybrid over the average of the parent.

The following table summarizes the results of twenty hand-pollinations with respect to the characters that appeared in the same season that the crosses were made:

TABLE III.—*Xenia characters appearing in twenty crosses of Chinese corn.*

Types of parent plants.	No. of seeds.	Aleurone color.			Endosperm color.			Endosperm texture.		
		Parents.		F_0 generation.	Parents.		F_0 generation.	Parents.		F_0 generation.
		♀	♂		♀	♂		♀	♂	
China white × China white	470	Absent	Absent	100 per cent absent	White	White	100 per cent white	Waxy	Waxy	100 per cent waxy.
Do	480	do	do	98.6 per cent absent	do	do	99.2 per cent white	do	do	99.4 per cent waxy.
Do	560	do	do	100 per cent absent	do	do	100 per cent white	do	do	100 per cent waxy.
Do	300	do	do	do	do	do	do	do	do	Do.
Do	29	do	do	do	do	do	82.8 per cent white	do	do	96.6 per cent waxy.
Do	280	do	do	do	do	do	99.6 per cent white	do	do	100 per cent waxy.
White dent × China white	544	do	do	do	do	do	100 per cent white	Horny	do	100 per cent horny.
Hopi white × China white	288	do	do	do				Starchy	do	100 per cent starchy.
White dent × China white	392	do	do	do	White	White	99.7 per cent white	Horny	do	100 per cent horny.
Mexican dent × China white	504	do	do	do	do	do	100 per cent white	do	do	Do.
Laguna × China white	350	do	do	do	do	do	do	Horny and starchy.	do	100 per cent horny and starchy.
Mexican shoe-peg × China white	200	do	do	do	do	do	do	do	do	Do.
Hopi black × China white	420	Present	do	100 per cent present	do	do	do	Starchy	do	100 per cent starchy.
China white × Guatemalan black	180	Absent	Present	100 per cent mottled	do	do	100 per cent ? white	Waxy	Starchy	100 per cent ? starchy.
Mexican shoe-peg × China mixed	125			100 per cent absent				Horny	Waxy	100 per cent horny.
China mixed × Mexican starch	431	Present ?	Absent	88.3 per cent present						
China yellow × China yellow	400	Absent	do	100 per cent absent	Yellow	Yellow	100 per cent yellow[a]	Waxy	Waxy	100 per cent waxy.
Do	560	do	do	do	do	do	do	do	do	99.8 per cent waxy.
China mixed × China mixed	320	Present ?	Present ?	100 per cent present						
China red × China red	398	do	do	78.4 per cent present						

[a] Many very pale.

HISTORICAL ACCOUNTS OF MAIZE IN CHINA.[a]

The discovery in China of a variety of maize with characters not known in American varieties of the species is not without interest from the historical point of view. Whether maize was known in the Eastern Hemisphere before the discovery of America was a warmly disputed question some decades ago, but since De Candolle's studies and his definitely negative conclusions were published, most writers have accepted his view.[b]

The finding of this unique variety of maize in China suggested a reexamination of the data on which De Candolle's conclusions were based. It now appears that important considerations have been overlooked and that the question is far from being settled. The issues have been confused by the failure to distinguish between two radically different points of view, the origin of the species in Asia and the possibility of its introduction into that continent in pre-Columbian times. Regarding the first question there can be but one opinion. Maize is of American origin. To many writers the mass of evidence that showed the widespread use and importance of corn in America at the time of the discovery seemed to preclude the idea that it could have existed at the same time in Asia. The other cultivated plants that are now known to have been extended on both sides of the Pacific show that the presence of maize in China would in no way conflict with the generally accepted fact that the maize plant is a native of America. The possibility that maize might have been introduced into China before the discovery of America by Europeans is to be considered quite alone on the basis of historical evidence.

The most significant evidence to the effect that maize was known in China before the discovery of America is not, as De Candolle states, the mention of maize in the mediæval "Charter of Incisa," now held to be a forged document, but the descriptions of maize that occur in Chinese literature. Very little information exists in Europe or America regarding the scientific writings of the Chinese, but enough is at present available to show that De Candolle's conclusions may need to be modified.

The first serious attempt to canvass this class of information is found in an article by Hance and Mayers.[c] At the request of Mr.

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[a] The writer is indebted to Mr. Walter T. Swingle for assistance with the literature concerning maize in China.

[b] See De Candolle, A. C., Geographie botanique raisonnée, 1855, vol. 2, p. 942, and Origin of Cultivated Plants (International Scientific Series), 1886, p. 387.

[c] Hance, H. F., and Mayers, W. F. Introduction of Maize into China, Pharmaceutical Journal, ser. 3, vol. 1, December 31, 1870, pp. 522–525. Dr. H. F. Hance, one of the foremost authorities on Chinese botany, went to China from England in 1844 and remained in that country until his death in 1886. Mr. W. F. Mayers, a recognized authority on the Chinese language, lived in China from 1856 to 1878. See Bretschneider, E., History of European Botanical Discoveries in China, pp. 632–695.

Mayers a memorandum on the history of maize in China was prepared by Mei K'i-chao, the intendant of the grain revenue for the province of Kwangtung. This memorandum includes a list of the common names of maize and their derivations. All references to the introduction of the plant are vague, except for the repeated and definite statement that it came to China from the west, more particularly from "Si-fan," a name formerly applied to a region to the west of China, including parts of Tibet and possibly Turkestan. Mei K'i-chao adds that there is a tradition in the provinces of Yunnan and Kweichow that maize was introduced there by Ma Fu-po from Cochin China. Mayers adds in a footnote that Ma Fu-po was known to have headed an expedition against the Si-fan tribes to the west in A. D. 36, and that he may have brought maize from there rather than from the south. In conclusion Mei K'i-chao says:

> It is further noted that this grain was heretofore presented as tribute, but again no date is assigned. It is evident that its introduction must have taken place at a very early period; as, at the time when these works were compiled [1552 to 1632], no information could be procured.

In the article just mentioned Mr. Mayers gives translations of references to maize in early Chinese works. The most important of these is taken from the Pen ts'ao kang mu, a Chinese herbal or materia medica. The author, Li Shi-chen, was born in the early part of the sixteenth century and began this work in 1552. It was completed in 1578, having been rewritten three times by the author, and after his death was laid before the Emperor by the author's son and published the same year, about 1596.[a]

The figures of maize reproduced in Mr. Mayers's article are well known and have frequently been copied, but the translation seems to have passed unnoticed. De Candolle refers to the article, but admits not having seen it.

Mr. Mayers's translation of the paragraph of the Pen ts'ao kang mu that refers to corn is given below with very slight corrections.[b]

> The seed of the *Yü-shŭ-shú* came from the lands on the West, and it is cultivated by but few. Its stalk and leaf both resemble the *Shŭ-shú* [sorghum [c]], but are more fleshy and shorter. They also resemble the [*i-i*] *Coix lachryma;* the stalk grows to a height of 3 or 4 feet; it flowers in the sixth or seventh month, producing an ear like that of the *Pi-mé*. From the heart of the stalk there issues a sheath in shape like the *Tsung* fish, from which a white waving beard grows out. After a time the sheath opens and the

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[a] Bretschneider, E. Botanicon Sinicum. Journal of the North China Branch of the Royal Asiatic Society, n. s., vol. 16, p. 55. Shanghai, 1892.

[b] Book 23, p. 23 r^{o}, edition of 1646, a copy of which is in the Library of Congress.

[c] Wu Ki-sün. Chi wu ming shi t'u k'ao (original part), book 1, p. 44, gives under this name an excellent picture of a compact-headed sorghum similar to the durras of northern Africa and western Asia.

grain comes forth. The grains are clustered together, each one as large as a *Tsung* seed [a palm, probably *Trachycarpus excelsa*], and yellow and white in color; they may be eaten baked or roasted. When roasted, they burst into a white flour-like mass, similar in appearance to that produced when rice of the glutinous kind is roasted.

The two figures given by Mayers from two different editions of the Pen ts'ao kang mu are crude and might be taken to represent any large-leaved, erect grass with a large terminal inflorescence. The text, on the contrary, leaves no room for doubt that the plant referred to is in reality maize. The height of 3 or 4 feet of course refers to Chinese feet of about 14 English inches. The "white waving beard" accurately describes the silks and would not apply to any other grass; this feature is shown in all the illustrations, even though the artist places the ear at the top of the plant. The opening of the sheath or husks can be understood, since the tip of the ear is commonly exposed in small varieties of maize.

Another contemporaneous reference to maize in China is given by Mendoza, an Augustine monk, who compiled the reports of the early Portuguese and Spanish missionaries in China, in a book published in 1585.[a] The first part, which contains the references to maize, was based on the accounts of Martin de Herrada and Geronimo Marin, who visited China in 1575. Herrada was a scholar familiar with the Chinese language, while Marin is described as "a native of Mexico, a man equally distinguished for his piety and learning."[b] To a native of Mexico the positive identification of maize would be certain, especially as the reference is made in the following specific manner:

On their high grounds, that are not good to be sowne, there is great store of pine trees, which yeelde fruite very sauorie: chestnuts greater, and of better tast, then commonly you shall finde in Spaine: and yet betwixt these trees they do sow maiz, which is the ordinarie foode of the Indians of Mexico and Peru.

The possibility of maize being a recent introduction would seem to be precluded by a second reference where this grain is referred to as one of the commodities paid as tribute to the King of China at a time that was considered ancient in 1575.

The rent which remaineth vnto the king ordinarily is this that followeth, and is taken with great regard out of the booke of his exchecker. Yet the Chinos do say that it is much lesse then that they do pay at this time; for that this is of old antiquitie, when as the tributes were lesse: . . .

The reference to maize as a tribute is as follows:

Of wheat called Mayz, twentie millions two hundred and fiftie thousand hanegs [about 30 million bushels].

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[a] Mendoza, Juan Gonzales de. The History of the Great and Mighty Kingdom of China. (Parke translation, 1588.) Hakluyt Society reprint 1853, pp. 15 and 84.

[b] Mendoza, loc. cit., p. lxix.

Another reference to the use of maize as tribute appears in the following extract from Mr. Mayers's article:

> Apart from the Pun Ts'ao, notices upon the present subject have also been sought in the "*Kê Chih King-yüan*," or "Mirror of Classified Research," a vast cyclopædia of information in all departments of physical study practiced by the Chinese, with references under each heading to antecedent works. This collection, in twenty-four volumes, was published in 1735 by Chên Yüan-lung. It contains no reference to maize under the name of *Yü Shŭ-shú;* but describes the plant as *Yü-mê* (imperial wheat), in the following terms:
>
> "*Yü-mê*, or imperial wheat, originated in the Si-fan territory (the lands beyond the western frontier of China proper), and its ancient name was *Fan-mê*, or 'wheat of the foreign lands of the West.' Having been offered among tribute, it has received the name of imperial wheat. In its stem and leaf it is the congener of the *Ts'i*, or panicled millet, and, in its flower, of rice. The sheath inclosing the ear is like a closed fist, but longer. The beard resembles red threads. The seed is like the grain of the *Tz* plant, but large, lustrous, and white. The flower blooms at the top of the plant, and the seed (ear?) grows out from the joints." (Loc. cit., p. 525.)[a]

If maize existed in China in very early times it may be expected that conclusive proof of the fact will be found in the pre-Columbian Chinese literature. Bibliographies of Chinese literature cite a number of cyclopedias and other large works, published before the discovery of America, that treat, at least in part, of agricultural subjects, but it does not appear that these have been scrutinized for references to maize. A study of this mediæval Chinese literature would doubtless go far toward settling this interesting question.

No very great significance can be attached to the absence of references to maize in the accounts of early European travelers in China. The only really detailed account of China before the discovery of America is that of Marco Polo, who traveled extensively in China during the thirteenth century. That even this account is far from complete, however, is shown by the omission of any reference to tea, a plant of much more importance than corn, and which is known to have been cultivated in China since 2000 B. C.

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[a] This paragraph is without doubt identical with one occurring in the Liu ch'ing ji cha of Tien I-heng, discovered by Berthold Laufer (The Introduction of Maize into Eastern Asia, in Congrés International des Américanistes, Quebec, 1907, vol. 1, p. 232), who makes the case even stronger by using the word "formerly" in his translation of the second sentence of the paragraph, which he gives as follows: "Since it was formerly brought as tribute to the court, it has received for this reason the name 'imperial wheat' (yü mai)." The Liu ch'ing ji cha is not cited in any European bibliography of Chinese literature, but since the passage in question was embodied in a work of Wang Shih-mou, who died in 1591, Professor Laufer infers that Tien I-heng wrote "say, about the middle of the sixteenth century." It thus becomes of importance to find the exact date of this publication, apparently the earliest known Chinese reference to maize. Professor Laufer's paper is full of valuable information on the history of maize in Asia, but unfortunately came into the writer's hands too late for full utilization in the present paper.

De Candolle's negative conclusion would seem to be fairly offset, at least, by the affirmative opinion stated by Doctor Hance as follows:

> In my judgment, the remote date assigned by Chinese records to its introduction and the circumstance that the introducer is unknown are irreconcilable with the supposition that it was brought to this country by the Portuguese, their first arrival here, under Fernand Perez d'Andrada, being, I believe, in 1517, and the earliest notice of maize in European literature dating later than 1530. To those, finally, who urge the conflicting and erroneous opinions of the earlier European writers as to the country whence maize found its way to the West as a ground for regarding Chinese statements with equal distrust, I would answer that it is not logical to apply the same canons of criticism to Western and Chinese literature, the latter being, at the period in question, in a very different and comparatively far more advanced state of development. (Loc. cit., p. 523.)

At the same time it must be admitted that the present facts can not be said to exclude the possibility that maize might have reached China after the discovery of America. Contacts between America and the Orient occurred very soon after the discovery of America, and in some cases at least were very direct. One expedition under Cabral left Portugal in March, 1500, and reached Brazil on May 1 of that year. It remained in Brazil twenty-two days, and then proceeded direct to India.[a] Opportunity was thus afforded for the carrying of maize from America directly to the East Indies instead of by way of Europe. It is very difficult, however, to believe that maize could have become established as a cultivated crop and spread into China in seventy-five years, even if a definite introduction had been undertaken promptly by the Portuguese. If varieties of corn similar to the Chinese are found in Brazil, the fact may have bearing on the historical question.

CONCLUSIONS.

The variety of Indian corn here described was introduced from Shanghai, China, and appears to be distinct from all hitherto known types. The plants possess the following unique characters:

(1) *Erect leaf blades.*—The leaf blades on the upper part of the plant stand erect instead of being borne in a more or less horizontal position, as in the ordinary varieties.

(2) *Monostichous arrangement of leaf blades.*—In addition to the erect position of the blades, those on the upper part of the plant are in many cases all on one side of the stem.

(3) *Silks developed while still inside the leaf sheath.*—Instead of the ear pushing out before the silks appear, the silks are produced directly at the base of the leaf blades, before the young ears emerge.

(4) *New type of endosperm.*—The texture of the endosperm is unique, and can not be referred to either the starchy or horny types

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[a] Fiske, John. Discovery of America, vol. 2, p. 96.

common in our cultivated varieties. It resembles the horny endosperm in location and hardness, but differs in texture and optical properties.

The early development of silks and erect leaf blades combine to produce an adaptation which insures pollination and prevents the silks drying out. The pollen is blown against the erect leaf blades and accumulates in their bases. The silks are pushed into these accumulations of pollen and become pollinated before they are exposed to the air.

Xenia characters in hybrids appear for the most part to follow Mendel's laws. Colored aleurone is dominant to transparent aleurone; yellow endosperm is dominant to white endosperm, and horny endosperm is dominant to waxy endosperm.

The discovery in China of a distinct type of maize has bearing upon the historical question whether maize was known in the Orient before the discovery of America. Though maize undoubtedly originated in America, the nature of the historical evidence regarding the extensive cultivation of maize in China in the latter part of the sixteenth century seems to preclude the idea of very recent introduction, leaving open the possibility that this specialized type of corn has developed in China. The generally accepted view to the contrary is further thrown in doubt by references to its widespread use and introduction from the west that occur in Chinese literature published during the sixteenth century.

NOTE.—After the foregoing paper was in type a letter dated August 24, 1909, was received from Rev. J. M. W. Farnham, Mokansan, China. This letter confirms in a very gratifying way the ideas advanced regarding the adaptive significance of the peculiar characteristics of the variety of maize described in this bulletin.

With respect to the climatic conditions that prevail in the region where this variety of corn is grown, Mr. Farnham states, "There is usually a long dry spell at the time of flowering," and as an example of the effect of this dry weather on ordinary varieties he writes, "I have a good illustration of pollination failing in a dry time in a case of a small patch of 'Late Mammoth' from which we are now eating. In gathering corn for the table to-day I found that probably half the ears, though large and well formed, had not a kernel of corn on them. Also many of the others had but a few kernels. There was protracted dry weather when this patch of corn was pollenizing."

Mr. Farnham also confirms the suggestion regarding the orientation of the plants with reference to a prevailing wind. "About 30 per cent of the plants have their leaves this way [on one side of the plant] and where there is this arrangement they face south. As I have said, the wind blows from the south pretty steadily all summer."

Mr. Farnham further states that there is a considerable area of this corn grown about Lieu-oo, twenty miles southwest of Shanghai, but it is not considered the principal crop. It is usually planted between the rows of cotton and is left to occupy the field after the cotton has been picked. A similar variety is grown at Taitsong, near Soochow, and on the island of Ch'ungming at the mouth of the Yangtze. The type is believed to be of local origin, and has been known personally to Mr. Farnham for thirty or forty years.

PLATES.

DESCRIPTION OF PLATES.

Plate I. (*Frontispiece.*) Chinese maize: Front and back view of the same plant. It will be noted that the leaf blades on the upper part of the plant are all on one side of the stalk and that they are erect and exceed the tassel.

Plate II. Fig. 1.—Chinese maize, showing silks protected by the base of the leaf blade. The photograph here reproduced was taken some time after pollination and the enlargement of the ear has forced the sheath away from the stalk. Fig. 2.—Upper part of a Chinese maize plant, showing the monostichous arrangement of the leaf blades. The base of the tassel appears in the upper part of the picture.

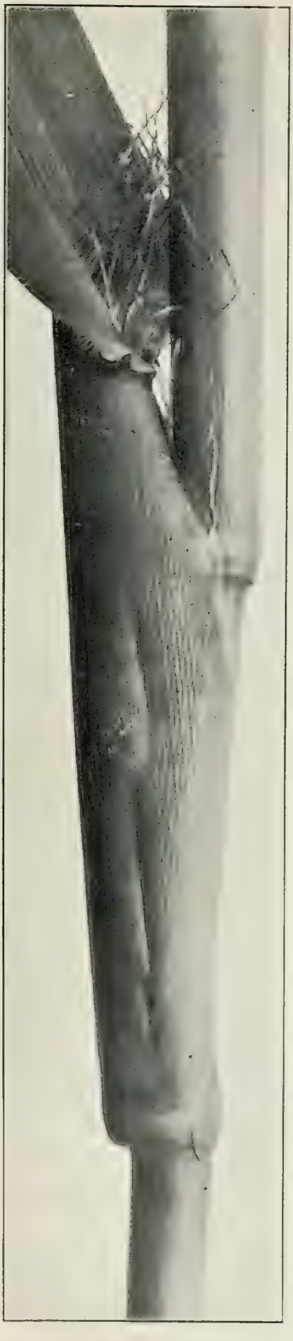

FIG. 1.—PART OF PLANT OF CHINESE MAIZE, SHOWING SILKS PROTECTED BY THE BASE OF THE LEAF BLADE.

(Natural size.)

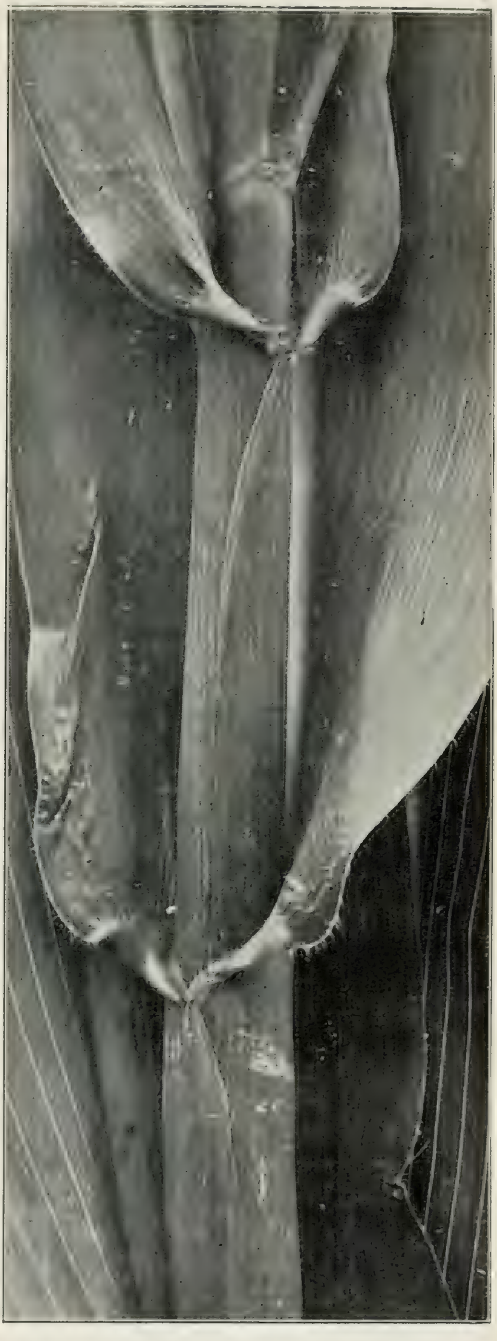

FIG. 2.—UPPER PART OF PLANT OF CHINESE MAIZE, SHOWING MONOSTICHOUS ARRANGEMENT OF THE LEAF BLADES.

(Natural size.)

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 162.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM JANUARY 1 TO MARCH 31, 1909:

INVENTORY No. 18; Nos. 24430 to 25191.

Issued December 24, 1909.

1862 1889

239487
17 1 30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

BUREAU OF PLANT INDUSTRY.

Chief of Bureau, BEVERLY T. GALLOWAY.
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 11, 1909.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 162 of the series of this Bureau, the accompanying manuscript, entitled "Seeds and Plants Imported during the Period from January 1 to March 31, 1909: Inventory No. 18; Nos. 24430 to 25191."

This manuscript has been submitted by the Agricultural Explorer in Charge of Foreign Seed and Plant Introduction with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—508.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM JANUARY 1 TO MARCH 31, 1909: INVENTORY NO. 18; NOS. 24430 TO 25191.

INTRODUCTORY STATEMENT.

The eighteenth inventory, including 761 numbers, comprises the period between January 1 and March 31, 1909, and contains the collections of only one agricultural explorer, Prof. N. E. Hansen, of South Dakota, whose eight months' trip into central Asia was made primarily to secure sufficiently large quantities of the seed of three wild Medicagos to enable extensive experiments to be carried out in the Northwest in testing their hardiness.

These three species, which Professor Hansen believes are going to prove valuable additions to the forage-crop resources of the Northwest, are as follows: No. 24451, *Medicago ruthenica*, from Charonte, Mongolia, an arm of the Gobi Desert, where the temperature drops to the freezing point of mercury at times when there is little snow on the ground and where in summer the temperature goes above 100° F. This species is a wild forage plant growing in the sandy region of eastern Siberia and may be of value either as a cultivated plant like alfalfa or, if allowed to run wild on the ranges, may become a valuable hardy forage legume. No. 24452, *Medicago falcata*, from Obb, in the Tomsk Province, a long-lived legume of the open steppes, is upright enough to be mown by a mowing machine; will withstand extremes of drought and cold, and is so promising in its own home as to have attracted the attention of the Russian agricultural experimenters as worthy of domestication and also as being of distinct value as a wild pasture plant in western Siberia. Professor Hansen emphasizes its value for all regions in this country where the common alfalfa is often winterkilled, but does not maintain that in regions where any of the true alfalfa strains can be grown successfully it is likely to prove superior. No. 24457, *Medicago platycarpa*, from Chylim, in the Tomsk Province, is a wild legume found in timber clearings and along the edges of forests of central Siberia. This is not a drought-resistant form, but perhaps rather a moist-region plant worthy of trial in northern Wisconsin and Minnesota. Owing to the immense value of any plant which may take the place of alfalfa in regions where this remarkable crop can not be grown, these new Siberian alfalfas are receiving the special attention of the forage-crop experts of the Department of Agriculture. They are the most interesting of more than a hundred and seventy things brought by Professor Hansen from Siberia, though others worthy of mention here are a number of durum wheats; remarkable winter muskmelons (some of them weighing 30 to 40 pounds and capable of keeping all winter, promising possibilities for the Southwest); the Persian clover shaftal or "Shabdar" (No. 24548), now being tried for the irrigated Southwest; and sand binders (Nos. 24555, 24556, 24557, 24558, and 24559) used along the Transcaspian Railway.

Numbers 24759 to 24761 represent the largest importation of bamboo plants ever brought into the country, comprising more than 3,000 good-sized plants of the three timber species that are grown so extensively in Japan—two of them for timber and one also for its edible shoots. These were purchased by an agent from the Japanese farmers near Nagasaki and brought over by the courtesy of the War Department on an army transport. They have made a satisfactory start at Chico, Cal., and will be planted in the South and in California this autumn. An effort will be made to show what a wonderfully beautiful thing a bamboo grove is, and to bring this unique timber material near enough so that our experimenters can study the methods of its utilization in the fresh state.

Of the introductions secured through correspondence, special attention should be called to the following:

Of interest to the fruit growers will be the three Javanese fruits—the Doekoe (No. 24431), the Ramboetan (No. 25163), and the Poelasan (No. 25164)—delicious East Indian fruits that seem to have not yet attracted attention in the West Indies; a South China relative of the orange (*Atalantia bilocularis*) for breeding purposes; the Indian bael fruit (No. 24450), which is prized for sherbets by Occidentals, but esteemed as highly as the orange by the East Indians, and its near relative from the Philippines, *Belou glutinosa* (No. 24591), both of which Mr. Swingle suggests should be used in breeding new types of citrus fruits; the edible passion fruit of Mexico, a much neglected fruit possibility for the Southwest; *Diospyros ebenaster*, the Zapote Prieto of Mexico (No. 24600), a relative of the persimmon; a new fine-flavored mango, with fruit the size of an English walnut, from Tahiti; strains of the Chilean strawberry (Nos. 24654–24656); five varieties of Chilean anonas (Nos. 24661–24665); the Legrellei pomegranate (No. 24825) from Switzerland, an unusually hardy form which matures its fruit in Paris; a collection of valuable pomegranates from Bagdad, Arabia (Nos. 25001–25007); two southern China peaches from Canton (Nos. 24915–24916); the cherry stock used by the Japanese and upon which they bench-graft all their ornamental flowering cherries and which seems not to have been tried for a stock for our fruiting cherries (No.

25087); and an interesting aromatic fruit from East Africa, the Kafir orange (No. 27170).

To those working with cereals and forage crops the following will be of interest: The Japanese rice (No. 24441) which, according to the Hawaii Agricultural Experiment Station, promises to supersede other Japanese types in Hawaii; the Jowar Sholapuri, a new class of Indian durra (No. 24442); a collection of soy beans (Nos. 24672–24690) from India; the Old German Frankish lucern (No. 24767) from near the home of Wendlin Grimm, who originally introduced the remarkably hardy Grimm alfalfa into Minnesota; Chinese grains (Nos. 24845–24850) from an altitude of 11,000 feet in the Yangtze Valley; and an unusual collection of grains from the uplands of Abyssinia.

To those interested in the rubber industry, a new East African rubber tree, producing rubber of the "Landolphia kirkii" type, from Mr. Barrett (No. 24637), and the famous virgin rubber tree of Colombia, South America (No. 24640), which yields rubber of the very highest quality and is capable of cultivation, will be worthy of notice.

To those who are in search of new ornamentals and comfort plants, the Chinese pistache (No. 24659) from Shantung, a promising tree for dry regions, resembling somewhat the pepper tree (*Schinus molle*), and the sycamore fig of the north coast of Africa (No. 25094), one of the most beautiful shade trees of the region, are worthy of especial consideration; while the introduction of the "Kiat" tree of Abyssinia will interest those who do not realize that a million or so of people in Arabia and Abyssinia depend upon the narcotic in its leaves quite as much as Americans do on tobacco.

David Fairchild,
Agricultural Explorer in Charge.

Office of Foreign Seed and Plant Introduction,
Washington, D. C., September 10, 1909.

INVENTORY.

24430. MEDICAGO SATIVA L. **Alfalfa.**

From Arequipa, Peru. Purchased from Borger & Guzman, through Mr. C. V. Piper. Received January 2, 1909.

Peruvian.

24431 to 24433.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Department of Agriculture. Received January 5, 1909.

The following seeds:

24431. LANSIUM DOMESTICUM Jack. **Doekoe.**

"The doekoe is one of the most refreshing fruits of the Dutch East Indies, and is eaten in immense quantities both by the native Javanese and the Dutch. It is about the size of a French prune, of a straw color, and the leathery rind, which is easily peeled off, exposes a pulp of a peculiar, almost waxy, texture. The several segments into which this pulp divides contain each a large seed, which is intensely bitter to the taste, so that care is always exercised in eating the fruit not to bite into the seed. The flavor is mildly subacid and decidedly refreshing. While not to be ranked with the mangosteen, the doekoe, in my opinion, is worthy of serious consideration as a new fruit for shipping purposes." (*David Fairchild.*)

Distribution.—Widely cultivated in India, and probably a native of the Malay Archipelago; also reported from the Philippines.

24432. GARCINIA TINCTORIA (DC.) W. F. Wight.

Distribution.—A native of the mountains of India, extending from the Himalayas south to the Andaman Islands.

24433. ATALANTIA BILOCULARIS (Roxb.) Wall. (LIMONIA BILOCULARIS Roxb.)

A small shrub, armed with solitary, long, sharp spines. The leaves are alternate, elliptical in outline, wavy margined, and firm and glossy. The small, pure white flowers are borne in axillary clusters. The black berries are about the size and shape of a pea and are succulent.

Distribution.—A native of the southeastern part of China and of the islands of Hainan and Formosa.

24434. PANICUM MUTICUM Forsk. **Para grass.**

From Tampico, Mexico, whence it was secured by Mr. John Kennedy, of Sarita, Tex., who presented the same to this Department. Numbered for convenience in recording distribution, January 5, 1909.

"Distinct from ordinary strain of Para grass. More vigorous and recovers more quickly after cutting, and decidedly superior." (*S. M. Tracy.*)

24437. Asparagus filicinus Hamil.

From Nocera Inferiore, Italy. Presented by Mr. Willy Müller. Received January 5, 1909.

"This species was originally collected by Buchanan-Hamilton in Nepaul, but has since been found in many localities extending from Burma to the western Himalaya, and thence northward to Mongolia. It is erect in habit and attains a height of nearly 4 feet, having horizontally spreading branches. The slender, flattened phylloclades are about one-third of an inch long and are borne in clusters of about five. The greenish white flowers are seated on slender pedicels about twice as long as the phylloclades." (*Gardener's Chronicle, August 15, 1908.*)

24438 to 24440.

From Kingston, Jamaica. Received through Mr. William Harris, superintendent of public gardens, Department of Agriculture, Hope Gardens, January 5, 1909.

24438. Zinziber officinale Rosc. **Ginger.**

Rhizomes. Procured for Dr. R. H. True's experiments at Orange City, Fla.

24439. Persea gratissima Gaertn. f. **Avocado.**

Seeds.

24440. Indigofera anil L.

"Seeds of a leguminous shrub reaching a height of several feet and distinguished from the common indigo (*Indigofera tinctoria*) by having short, compressed, sickle-shaped pods and by its capability of being propagated by means of cuttings. Indigenous in Tropical America, and occurring from the Carolinas to Brazil. Formerly widely cultivated in both the eastern and the western hemispheres, and together with *I. tinctoria* an important source of indigo. Now, too, found in waste places from North Carolina to Florida and Louisiana. It is no longer cultivated commercially in the United States, since the introduction of substitutes has rendered indigo production unprofitable." (*W. W. Stockberger.*)

24441. Oryza sativa L. **Rice.**

From Honolulu, Hawaii. Presented by Mr. F. G. Krauss, in charge of rice investigations, Hawaii Experiment Station. Received January 6, 1909.

"Variety No. 164, 34 to 40 inches tall. A strong, erect grower, tillers well, and bears heavily a kernel of good quality. Mature in 120 days. One of the best Japan rices grown at the Hawaii station. We give preference to this variety, which promises to supersede other Japan types in Hawaii." (*Krauss.*)

24442 to 24447.

From Sholapur, India. Presented by M. A. Peacock, esq., treasurer, the American Marathi Mission. Received December 26, 1908.

The following seeds, native names, and notes by Mr. Peacock:

24442 and 24443. Andropogon sorghum (L.) Brot. **Durra.**

24442. *Jowar Sholapuri.* Stalks often grow 10 feet tall; heads mammoth.

"White. This is a medium-sized head, rather compact, with a rather small, flattened, white seed inclosed in transversely wrinkled, mostly pale, glumes; florets awned. Apparently represents a group not heretofore introduced." (*Carleton R. Ball.*)

24442 to 24447—Continued.

24442 and 24443—Continued.

24443. *Jowar.* Double variety.

"White. A very small head, probably dwarfed by thick sowing and adverse conditions; ovate, compact, two seeds in each spikelet; seeds small, white; glumes pale; florets awned. Belongs to group 8 of India sorghums represented by S. P. I. No. 14603, etc." (*Carleton R. Ball.*)

"The *Jowar* furnishes an excellent fodder in its stalks and the grain is highly nutritious. At certain times of the year it furnishes the chief grain for the food of India's millions in the Deccan." (*Peacock.*)

24444 to 24447. PENNISETUM AMERICANUM (L.) Schum. **Pearl millet.**

24444. *Common Country Bazra.*

"There seem to be several widely different strains included in this lot." (*H. N. Vinall.*)

24445. *Pure African Bazra.*

24446. Cross-breeding *Common Country* and *African Bazra.*

24447. *Bearded Bazra.*

"The presence of numerous bristles probably accounts for the fact that it is less troubled by attacks from birds." (*H. N. Vinall.*)

"The *Bazra* is more of a food grain and is scarcely ever fed to animals on account of its expense. Both these grains grow on the poorly cultivated semiarid plains of the Deccan." (*Peacock.*)

24448 and 24449. PHASEOLUS COCCINEUS L. **Scarlet runner bean.**

From Italy. Presented by Mr. Haven Metcalf, pathologist in charge, Laboratory of Forest Pathology, Department of Agriculture. Received December 24, 1908.

24448. "Obtained at the Tenute Consorti Sullam in Portotolle e Taglia Di Po, in the province of Rovigo, Italy. These beans were called by the grower, Dr. Angelo Sullam, '*Faggioli Elefanti di Prussia.*' He has been growing them for some years on his plantation, which is largely devoted to rice, and where I saw these beans growing in rather sandy land, with a water table not more than 6 or 8 inches under the surface. According to Doctor Sullam, this bean grows readily on wet land, although it will not grow directly in water. It twines or runs and flowers freely and continuously. I ate the beans cooked in the form of salad and found them very palatable, with more the flavor of a white bean than our ordinary Lima or colored beans. It occurs to me that this may be valuable on wet land; it is said not to grow well at all on dry land. As I did not see any growing on dry land, I can not bear witness to this. Doctor Sullam originally obtained his seed from western Russia." (*Metcalf.*)

24449. "Obtained near Ferrara. The beans were there being grown under the name of '*Faggioli Elefanti da Istria.*' So far as I could see these were exactly the same bean as the first sample (S. P. I. No. 24448). The seed in this case was said to have been obtained from Istria." (*Metcalf.*)

24450. BELOU MARMELOS (L.) W. F. Wight. **Bael tree.**

From Lahore, Punjab, India. Presented by Mr. W. R. Mustoe, superintendent, Archæological Gardens. Received January 8, 1909.

"Seed of the large-fruited variety of *Aegle marmelos* (*Belou marmelos*), known to Europeans as bael fruit. It has three vernacular names, i. e., bill, bel, and bael. It is

24450—Continued.

a handsome tree, with dark-green, shining leaves which have a resinous odor; it is common in the greater part of India, growing up to 4,000 feet; when cultivated is a middle-sized tree of 35 feet, but when wild is a scrubby tree.

"The leaves, roots, bark, and fruit are used in native medicines and the last named in European medicines also, and from the flowers a scent water is distilled.

"Bael is cultivated for its fruits and as a sacred tree, being thought a lot of for worship of the god Shiva, and is one of the few woods prescribed by the Hindoo scriptures for sacrificial fires. The wood is close grained, tough, and strong, but often splits in seasoning.

"The leaves, bark, and roots are used as a febrifuge and the first mentioned is also lopped for cattle fodder.

"The unripe fruit, either boiled or roasted, is used as a specific for diarrhea and dysentery. When ripe it is very much like an orange in shape, color, and size, but has a hard shell, which is sometimes made into snuffboxes; the pulp of the fruit is a laxative and when mixed with milk or soda water, or both, makes a healthy, cooling, and agreeable sherbet. To make this they take the pulp of the fruit out of the shell and put it into a little water, then pass it through a strainer, and put it into a glass of milk or soda water and sugar to taste. The pulp is also used to strengthen mortar for building purposes and the mucus with which the cells are filled is used as a glue; also used with water paints to add to their strength and brilliancy. This fruit is greatly valued for eating by the natives, but can scarcely be looked upon as palatable to the white man except as a sherbet and for its medicinal properties. The tree comes true to seed and is not grafted. It might be tried in several districts, as it grows equally as well up here as in Calcutta, where the air is moist and hot all the year round, and here it is very dry and hot in the summer, with a temperature of 112° to 120° F. in the shade, and in the winter with sometimes 12 degrees of frost at night; but the bael always looks healthy and green, no matter what the weather is. It is leafless for about one month only, January or February, and its one year's fruit is ripe at about the same time that it is flowering for the next year's fruit.

"This is really a valuable tree both from a decorative and economic point of view, and I do not consider it gets the attention in India that it should." (*Mustoe.*) For further description and previous importation, see No. 22957.

Introduced at Mr. Walter T. Swingle's suggestion for use in breeding new types of citrus fruits.

24451 to 24575.

From northern and central Asia. Received through Prof. N. E. Hansen, of the Agricultural Experiment Station, Brookings, S. Dak., while traveling as an agricultural explorer for the Department of Agriculture, December 3, 1908.

The following seeds:

24451. MEDICAGO RUTHENICA (L.) Trautv.

"(No. 59.) From same source as No. 58 (S. P. I. No. 24456). This is a favorite wild forage for the stock kept by the Mongolian nomads of this region, should be tested in the driest, coldest parts of the Northwest, especially where the most extreme cold comes at times without snow on the ground. For a common name Gobi Desert, Mongolian, or East Siberian alfalfa will do." (*Hansen.*)

Distribution.—A native of stony and sandy regions of Siberia, extending east to the region of Lake Baikal, and into China.

24451 to 24575—Continued.

24452 to 24456. MEDICAGO FALCATA L.

24452. "(No. 66.) The main lot of western Siberian alfalfa gathered growing wild on the open steppe, with the help of 200 peasants, a few miles from Obb, Tomsk Province, where the Obi River crosses the Siberian railway. One of the most characteristic and dominant plants of the open steppes in Tomsk Province, western Siberia. The falcate or sickle-shaped pods of this alfalfa give it the specific name *falcata.* A long-lived perennial, with strong, deep-growing taproots, holding its own with other native plants in dense sod and enduring pasturing. Highly regarded by the peasants as a pasture plant and for hay. Cattle, horses, and sheep are all fond of the plant. Worthy of thorough trial in all regions where the common alfalfa suffers from winterkilling. Where common alfalfa, which is native of a much milder climate than that of our Prairie Northwest, is perfectly hardy, I would suggest 'Let well enough alone.' However, it will be well to remember that this plant, while primarily intended for the severest regions, endures more pasturing than common alfalfa, and may be found valuable to introduce into native pastures as a wild plant farther south. Plant breeders should be quick to isolate the elementary species in *Medicago falcata* and to remember that the many different lots of *Medicago falcata* gathered in my second and third trips to Siberia should be carefully kept separate. The most southern lots should go more into the Central West, the northern lots into the most northern sections. The species varies in its native haunts and should be regarded as consisting of many elementary species, differing widely in important characteristics. The yellow flowers are attractive and much visited by bees." (*Hansen.*)

24453. "(No. 90.) As found wild on open steppe at Omsk, Akmolinsk Province, western Siberia. See No. 66 (S. P. I. No. 24452)." (*Hansen.*)

24454. "(No. 86.) See No. 66 (S. P. I. No. 24452). This lot is from north of Irkutsk, near western shore of Lake Baikal, eastern Siberia, and extending to a hundred miles north, among the Buriats, a Mongolian tribe. This region is moister in climate than farther east on the open steppe, so may be found better adapted for regions like northern Maine, Minnesota, and Wisconsin." (*Hansen.*)

24455. "(No. 28.) One of the three yellow-flowered Siberian alfalfas. This seed was gathered on the east bank of the Irtysh River about ten miles north of Semipalatinsk, in the province of the same name, western Siberia. Plants with stems 5 feet 8 inches long were found. Of erect habit. Both as growing in the wild pasture and as hay the plant is well liked by stock. The plant is also much visited by bees." (*Hansen.*)

24456. "(No. 58.) Although but a small quantity of seed, this number should receive special attention, as it is from the farthest point east where I found this Siberian alfalfa. Seed gathered in almost pure sand at station Charonte, in an arm of the Desert Gobi, a few miles from Chinese territory on the Siberian railway. This is in the Mongolian part of Manchuria, Manchuria proper not beginning till after crossing the Chinese mountains. This region is marked by great extremes of heat and cold, and especially by the fact that often cold sufficient to freeze mercury is experienced with no snow on the ground." (*Hansen.*)

Distribution.—A native of Europe and Asia, extending from Sweden to China.

24451 to 24575—Continued.

24457. Medicago platycarpa (L.) Trautv.

"(No. 73.) A strong-growing perennial yellow-flowered alfalfa found wild in timber clearings and along edges of the forests in central Siberia. The name *platycarpa* refers to the large flat pod. This alfalfa should be thoroughly tested in regions like northern Wisconsin and Minnesota. Will endure extreme cold, but probably not severe wind sweep as well as *Medicago falcata* and *Medicago ruthenica*. This lot was gathered near Chylim, between Obb and Omsk, in Tomsk Province, western Siberia. All the three Siberian alfalfas are yellow flowered." (*Hansen.*)

Distribution.—Found throughout Siberia, extending east as far as Lake Baikal.

24458 to 24460. Trifolium lupinaster L.

24458. "(No. 94.) As found native at Chita, Transbaikal region, on Siberian railway. See No. 68 (S. P. I. No. 24817)." (*Hansen.*)

24459. "(No. 92.) As found native at Chita, Transbaikal region, on Siberian railway. See No. 68 (S. P. I. No. 24817)." (*Hansen.*)

24460. "(No. 78.) This lot was gathered on the open steppe just north of the Altai Mountain range between Biisk and Beloglasowo, southern Tomsk Province, western Siberia. Worthy of introduction into the western ranges as a wild plant, and for trial as a cultivated clover wherever trouble is experienced from the winterkilling of the common red clover. See No. 68 (S. P. I. No. 24817)." (*Hansen.*)

Distribution.—A native of Asia, extending from central Russia through Siberia, Mongolia, and Manchuria; also in Japan.

24461. Trifolium medium Huds.

"(No. 69.) Mammoth red clover as found wild near Obb, Tomsk Province, at the intersection of the Siberian railway and the Obi River. All the Siberian clovers should receive careful attention, as they may be found especially adapted to our Prairie Northwest where trouble is experienced from the winter-killing of the common red clover." (*Hansen.*)

Distribution.—A native of open woods and fields in northern and central Europe and across Asia to the region of Lake Baikal.

24462. Vicia cracca L.

"(No. 67.) A vetch gathered growing wild on the open steppe near Obb, Tomsk Province, western Siberia, where the Obi River crosses the Siberian railway. Common on the open steppes. Not cultivated here as yet, as the country is too thinly settled." (*Hansen.*)

24463. Vicia cracca L.

"(No. 88.) As found wild on open steppe at Omsk, Akmolinsk Province, western Siberia." (*Hansen.*)

24464. Vicia amoena Fisch. (?)

"(No. 64.) A wild vetch gathered at village Verk-Tchitinskaya, 20 versts north of Chita, Transbaikal region, Siberian railway." (*Hansen.*)

Distribution.—A native of central Siberia, extending from the Ural Mountains to the region of Lake Baikal.

24465. Vicia tenuifolia Roth.

"(No. 13.) A native vetch on open steppe at Beloglasowo, between Biisk and Smeinogorsk, southern Tomsk Province, western Siberia." (*Hansen.*)

Distribution.—A native of Europe and Asia, extending from central Russia to Lake Baikal.

24451 to 24575—Continued.

24466 to 24468. Agropyron imbricatum (Bieb.) R. & S.

24466. "(No. 63.) A grass of very wide distribution in northern Asia and European Russia. Highly recommended as one of the best grasses in the Volga River region of eastern European Russia, where it was brought into culture by the experiment station at Waluiki near Rowno, south of Saratow. In my Russian trip in 1897 I saw the beginnings of this work by Mr. Bogdan, at that time director of the station. The present sample was gathered wild by myself and helper in the sand semidesert region at the station Manchuria, the first station in Chinese territory going east on the Siberian railway." (*Hansen.*)

24467. "(No. 87.) See No. 63 (S. P. I. No. 24466). This lot was collected at Charonte, a few miles into Chinese territory, in the Mongolian part of northwestern Manchuria, where an arm of the Gobi Desert is crossed by the Siberian railway." (*Hansen.*)

24468. "(No. 91.) As found native at Chita, Transbaikal region, on Siberian railway. See No. 63 (S. P. I. No. 24466). A valuable grass on dry steppes." (*Hansen.*)

Distribution.—A native of Europe and Asia, being found from Russia to Spain and east to Siberia and Afghanistan.

24469 and 24470. Elymus sibiricus L.

24469. "(No. 12.) A common grass of dry steppes at Beloglasowo, between Biisk and Smeinogorsk, southern Tomsk Province, western Siberia. For further study as to value by agrostologists only; not for distribution." (*Hansen.*)

24470. "(No. 82.) A native dry steppe grass gathered between Beloglasowo and Smeinogorsk, north of Altai Mountain range, Tomsk Province, western Siberia. Sample for agrostologists only." (*Hansen.*)

Distribution.—A native of Siberia, extending from the Ural Mountains to the region of Lake Baikal.

24471 and 24472. Lathyrus pratensis L.

24471. "(No. 14.) A wild pea common on the open steppes north of Altai Mountain range in the southern part of Tomsk Province. Seed gathered near Beloglasowo, between Biisk and Smeinogorsk. Its value as a field pea for regions like western Nebraska and Dakota should be tested." (*Hansen.*)

24472. "(No. 89.) A wild field pea from open steppe at Omsk, Akmolinsk Province, western Siberia." (*Hansen.*)

Distribution.—A native of Europe, Asia, and northern Africa, extending to the Pacific and from the Mediterranean to the Arctic Circle.

24473. Elymus arenarius L.

"(No. 26.) A coarse reed-like grass common in dry sand deserts, about 30 miles south of Semipalatinsk, in the province of the same name, western Siberia. A tall plant of striking appearance, not eaten by stock, but may be useful as a sand binder in sections with great extremes of cold and heat." (*Hansen.*)

Distribution.—Found on sandy shores throughout the Northern Hemisphere.

24474.

(No. 60.) A mixture of *Elymus* sp. and *Koeleria cristata* (L.) Pers., the latter predominating.

24451 to 24575—Continued.

24475. Agropyron caninum (L.) Beauv. (?)

"(No. 61.) A native grass common in timber and timber clearings near Chita, Transbaikal region, eastern Siberia. Forage value undetermined. Sometimes called '*ostretz*,' but this is applied properly to *A. pungens*." (*Hansen.*)

24476. Vicia unijuga A. Braun.

"(No. 65.) A native legume common in woods near Chita, Transbaikal region, Siberian railway. Food value undetermined, but *Orobus luteus* L., its relative, is eaten by stock and the young shoots used for food by the Chinese." (*Hansen.*)

Distribution.—A native of Asia, occurring throughout Siberia, and in Manchuria and China; also found in Japan.

24477. Avena sativa L. **Oat.**

"(No. 79.) Oats from the dry Belagatch steppe near Semipalatinsk, in province of same name, western Siberia. A region of great extremes of heat, cold, and drought." (*Hansen.*)

24478. Andropogon sorghum (L.) Brot. **Kowliang.**

"(No. 85.) Variety '*Gaolan*' from the Harbin district, bought in Chinese bazaar at Station Manchuria, the first station in Chinese territory going east on the Siberian railway. The favorite variety in northern Manchuria." (*Hansen.*)

"Brown kowliang from Manchuria. One of the common forms of the region." (*Carleton R. Ball.*)

24479. Glycyrrhiza uralensis Fisch.

"(No. 27.) Seed of wild licorice gathered on the banks of a tributary of the Irtysh River, about 30 miles south of Semipalatinsk, in province of same name, western Siberia. Its value for cultivation not determined, but the region where this seed was gathered is subject to great extremes of cold and heat." (*Hansen.*)

24480. Lavatera thuringiaca L.

"(No. 83.) A tall mallow-like dry-steppe flower collected between Biisk and Semipalatinsk, north of Altai Mountain range, Tomsk Province, western Siberia. Plant 4 to 6 feet in height, well branched; flowers mostly bright pink." (*Hansen.*)

Distribution.—A native of Europe and Asia, extending from central and southern Russia to the eastern part of Siberia.

24481. Triticum durum Desf. **Wheat.**

"(No. 81.) This lot is from the dry Belagatch steppe near Semipalatinsk, in province of same name, western Siberia." (*Hansen.*)

24482. Trifolium lupinaster L.

"(No. 84.) See Nos. 68 and 78 (S. P. I. Nos. 24817 and 24460). This 5-leaved clover, which ranges northward to the Arctic Circle in Siberia, is worthy of trial at the far north. The present lot is from Chailar, in northwestern Manchuria, on the Siberian railway." (*Hansen.*) See No. 24458 for distribution of this species.

24483. Triticum durum Desf. **Wheat.**

"(No. 117.) '*Ak-bugdai.*' '*Ak*' means white, '*bugdai*' wheat. A wheat from Tashkend, northern Turkestan. Very productive at Tashkend." (*Hansen.*)

24451 to 24575—Continued.

24484. Triticum aestivum L. **Wheat.**

"(No. 118.) '*Turbat*,' meaning land or country wheat, from 20 miles north of Tashkend, Turkestan. Turbat is the name of a place." (*Hansen.*)

24485. Triticum durum Desf. **Wheat.**

"(No. 129.) '*Kara-bugdai*,' meaning black wheat, from Tashkend, Turkestan. May be sown either as a winter wheat, from September to December, at Tashkend; or as a spring wheat, in February or March, but not later. This is on northern border of cotton belt. Usually sown as a spring wheat." (*Hansen.*)

24486. Triticum aestivum L. **Wheat.**

"(No. 131.) Native wheat from Old Chardchui, Turkestan, a very dry region." (*Hansen.*)

24487. Triticum durum Desf. **Wheat.**

"(No. 134.) '*Sary-magis*,' a native wheat from Tashkend, Turkestan. '*Sary*' means yellow. All the Turkestan wheats deserve special attention as a drought-resistant race." (*Hansen.*)

24488. Triticum durum Desf. **Wheat.**

"(No. 135.) '*Caucasian*' wheat from Tashkend, Turkestan." (*Hansen.*)

24489. Triticum sp. **Wheat.**

"(No. 137.) '*Kizyl-bugdai*,' meaning red wheat, from Tashkend, Turkestan." (*Hansen.*)

24490. Triticum durum Desf. **Wheat.**

"(No. 138.) '*Ak-bugdai*,' meaning white wheat, from Tashkend, Turkestan." (*Hansen.*)

24491. Triticum durum Desf. **Wheat.**

"(No. 139.) '*Sary-bugdai*,' meaning yellow wheat, from Tashkend, Turkestan." (*Hansen.*)

24492. Triticum durum Desf. **Wheat.**

"(No. 140.) '*Kara Kiltschik*' wheat from Tashkend, Turkestan. '*Kara*' means black." (*Hansen.*)

24493. Triticum durum Desf. **Wheat.**

"(No. 234.) Seed of native Turcoman '*Red Mountain*' wheat, raised on dry land without irrigation at Askabad, Turkestan, and found especially valuable at the Askabad Experiment Station." (*Hansen.*)

24494 to 24496. Cucumis melo L. **Muskmelon.**

24494. "(No. 119.) Winter muskmelon. '*Ak-bek-shek*,' meaning white melon. From Chardchui, Turkestan." (*Hansen.*)

24495. "(No. 120.) '*Gulakcha*,' a first early muskmelon from Chardchui, Turkestan." (*Hansen.*)

24496. "(No. 122.) Winter muskmelon. '*Kerkinsche*,' from Chardchui, Turkestan. Diameter 29 and 15 cm." (*Hansen.*)

24497. Hordeum vulgare L. **Barley.**

"(No. 123.) Native winter barley from Bairamalee, near Merv, eastern Turkestan. Drought resistant." (*Hansen.*)

24451 to 24575—Continued.

24498 to 24540. Cucumis melo L. **Muskmelon.**

24498. "(No. 124.) Winter muskmelon. '*Katschalinsky*,' from Chardchui, Turkestan." (*Hansen.*)

24499. "(No. 126.) Winter muskmelon. '*Khansky*,' from Chardchui, Turkestan. Diameter 38 and 22 cm." (*Hansen.*)

24500. "(No. 127.) Winter muskmelon, from Chardchui, Turkestan. Diameter 32 and 20 cm." (*Hansen.*)

24501. "(No. 128.) Winter muskmelon, from Chardchui, Turkestan. Diameter 23 and 22 cm." (*Hansen.*)

24502 to 24537. "(Nos. 150 to 185.) Native muskmelons of Turkestan, mostly winter varieties. No. 167 (S. P. I. No. 24519) is the largest lot of seed, from melons I bought in December, 1908, in the bazaar at Chardchui, Turkestan. In my opinion it is worthy of a most earnest effort on the part of a melon specialist to get these winter muskmelons of Turkestan introduced into the driest and hottest regions of our Southwest and the driest parts of our cotton belt. Some of the melons weigh from 30 to 40 pounds, with thick white flesh, and are extremely sweet. In Turkestan the late varieties are hung in reed-grass nets or slings from the ceilings in the native houses of sun-baked clay, ready for use all winter as needed. They are one of the main staples of the native diet. The melons are also pickled somewhat like watermelon rinds in America, but much superior in quality. Much of the muskmelon seed I brought from my first trip to Turkestan in 1907, and some in the spring of 1908, was lost from being tested too far north, in response to the great demand for the seed. Some melons of this first importation have done well in the Southwest and have since appeared under other names, by which the credit of introduction is lost. With this fresh lot of seed it is hoped that the Turkestan muskmelons, the largest and best in the world, will receive a thorough trial in the hottest, driest regions of the Southwest. None of them should go north of the cotton belt, unless it be some of the smallest and earliest varieties. A long period of hot, dry weather is needed to bring out the quality. Some of the varieties endure long-distance transportation, so that in these melons appears an inviting field for southern enterprise. Some of the varieties may prove too sweet for our tastes. The breeder of melons may find them useful in hybridizing. Southern California, New Mexico, Arizona, and southern Texas should receive the seed at first; later the range may extend farther northeast as the seed becomes more abundant. I can not insist too strongly on the necessity of giving these melons a long, hot, dry season for their best development." (*Hansen.*)

24538. "(No. 233.) Seed saved from three large, white muskmelons bought at Kagan or New Bokhara, Turkestan. Fruit oval, 12 to 15 inches in long diameter, clear, bright yellow; flesh white, very sweet. See Nos. 150 to 185 (S. P. I. Nos. 24502 to 24537)." (*Hansen.*)

24539. "(No. 236.) An oval, brownish yellow winter muskmelon with sweet, green flesh, 8 to 10 inches in length. Grown near Merv, Turkestan. In good condition December 17, 1908." (*Hansen.*)

24540. "(No. 244.) Seed of winter muskmelon saved from melons bought at Chardchui, Turkestan, December, 1908." (*Hansen.*)

24451 to 24575—Continued.

24541. Gossypium hirsutum L. **Cotton.**

"(No. 121.) Sample of Upland cotton originally from the United States, but cultivated at least fifteen years on northern limits of cotton belt in Turkestan, about 100 versts north of Tashkend." (*Hansen.*)

24542. Gossypium herbaceum L. **Cotton.**

"(No. 143.) Sample of the local native Bokhara cotton of Tashkend, Turkestan, on the northern limits of cotton culture. I took occasion to study the cotton industry while in Turkestan and found the opinion held by many that the introduction of American cotton seed in Turkestan was not an unmixed blessing. While American cotton is greatly superior to the native Bokhara type for the manufacturer, the American varieties were somewhat inferior in resistance to untimely frosts and were later in season. If this proves true, as a rule, it opens up an interesting field for cotton breeders in hybridizing the American and Turkestan cottons, if that is possible. For Turkestan it would help maintain culture where it is at present in a precarious condition, because of recent great failures from frosts on the northern limits of cotton culture; in America it might aid in the boll-weevil work and in forcing cotton culture a few miles farther north than at present." (*Hansen.*)

24543. Gossypium indicum Lam. **Cotton.**

"(No. 144.) '*Malla huza*' from Tashkend, Turkestan. '*Malla*' means yellow; '*huza*,' cotton. This is the native cotton used for 'Nah-mazh' or Mohammedan prayer rugs and other holy purposes; not generally sold, but is used mainly for presents. Every native Sart cotton grower raises a little for his own use. This native Turkestan may vary in some particular from the other nankeen or yellow cottons grown elsewhere." (*Hansen.*)

24544. Gossypium hirsutum L. **Cotton.**

"(No. 147.) Native '*Kara chigis*' cotton from Tashkend, Turkestan. '*Kara*' means black; '*chigis*,' seed. 'Somewhat like *Peterkin*, but at least two weeks earlier,' is the experience with it at the experiment station, Turkestan." (*Hansen.*)

24545. Gossypium hirsutum L. **Cotton.**

"(No. 149.) '*Tashkend Upland*' cotton, originally from the United States, but grown for many years at Tashkend, Turkestan. The name has changed. Said to be an early cotton." (*Hansen.*)

24546. Gossypium herbaceum L. **Cotton.**

"(No. 187.) Native Bokhara cotton as raised at Tashkend, Turkestan. See No. 143 (S. P. I. No. 24542)." (*Hansen.*)

24547. Gossypium herbaceum L. **Cotton.**

"(No. 189.) Another sample of '*Malla huza*,' the native yellow or holy cotton of central Asia, as grown at Tashkend, Turkestan. See No. 144 (S. P. I. No. 24543)." (*Hansen.*)

24548 to 24550. Trifolium suaveolens Willd. **Shaftal.**

24548. "(No. 125.) The main lot of Persian clover from Meshed, northeastern Persia, and grown one year at Tashkend, Turkestan. *Shabdar* is the Persian name; as grown in India it is called shaftal. An annual plant of extremely vigorous growth. In Persia and Afghanistan it is cut two or three times during the season. Flowers small, bright pink, very fragrant, much visited by bees. Adapted for the dry part of the cotton belt and for the driest regions of our Southwest. This cultivated form is decidedly stronger in growth than that occurring wild farther west into Europe and northern Africa." (*Hansen.*)

24451 to 24575—Continued.

24548 to 24550—Continued.

24549. "(No. 194.) From the original lot of Persian seed received at Tashkend, Turkestan, from Meshed, northeastern Persia. See No. 195 (S. P. I. No. 24550)." (*Hansen.*)

24550. "(No. 195.) Shabdar from Meshed, northeastern Persia, raised one year at experimental station, Golodnaya or Hunger steppe, Turkestan, between Tashkend and Samarkand." (*Hansen.*)

"Previous importations of shaftal by the Bureau of Plant Industry (S. P. I. Nos. 19506 and 19507, received December 10, 1906) are yielding promising hay crops in the Southwest. The present numbers are of interest, as they extend considerably the range from which seed has been secured. Meshed lies at an altitude of about 3,000 feet, while the upper Kuram valley, the center of seed production for northwestern India, where this is the only clover grown, has an altitude of nearly 5,000 feet." (*Charles J. Brand.*)

Distribution.—An annual clover, found in Persia, in the region of the Caspian Sea, and east to India.

24551. ORYZA SATIVA L. **Rice.**

"(No. 130.) A very early swamp, white rice, a Kirghiz Tartar variety, from Tashkend, Turkestan. Worthy of attention by rice breeders and may prove useful owing to its earliness." (*Hansen.*)

24552. ORYZA SATIVA L. **Rice.**

"(No. 148.) Dry-land rice from Tashkend, Turkestan." (*Hansen.*)

24553. ANDROPOGON SORGHUM (L.) Brot. **Durra.**

"(No. 152.) '*Ak-zhu-gah-rah,*' a native variety from Old Chardchui, Turkestan. This is extensively cultivated as a cereal in the driest regions of Turkestan, being better adapted to droughty conditions than maize." (*Hansen.*)

"'*Dzhugara,*' the common white durra of Turkestan. Extensively grown for human food." (*Carleton R. Ball.*)

24554. ANDROPOGON SORGHUM (L.) Brot. **Durra.**

"(No. 192.) A red-seeded variety grown by the Turcomen at Bairamalee, near Merv, Turkestan." (*Hansen.*)

"Brown durra. Never before introduced from Turkestan. A few seeds were found mixed in S. P. I. No. 18389, white durra, from Bassorah, Arabia. Similar forms are found along the northern edge of the Sahara. Very similar to our domestic brown durra." (*Carleton R. Ball.*)

24555. HALOXYLON AMMODENDRON (C. A. Meyer) Bunge.

"(No. 133.) One of the best native trees or arborescent shrubs of the sand deserts of Turkestan. Now much used as a sand binder for the dunes which cause trouble along the Transcaspian railway. The green wood burns freely, is very heavy, and is gathered in immense quantities for fuel. This tree might prove a valuable addition to the native flora in the driest sand deserts of our Southwest. The native name is *Saxaul.*" (*Hansen.*)

Distribution.—A native of central Asia, extending from the Ural to the Altai mountains and south into Persia.

24556. SALSOLA ARBUSCULA Pall.

"(No. 145.) A native arborescent shrub, native of the sand deserts of the Transcaspian region east of the Caspian Sea in Turkestan. This lot is from Chardchui, where the Russian Government has made extensive experiments in planting sand binders to hold the drifting dunes along the line of the Transcaspian railway. This species is one of the favorite plants for that purpose." (*Hansen.*)

Distribution.—A native of central Asia, from the Ural to the Altai mountains.

24451 to 24575—Continued.

24557. CALLIGONUM sp.

"(No. 240.) An arborescent shrub, native of the sand deserts of Turkestan, now used as a sand binder along the Transcaspian railway. See Nos. 133, 145, 241, and 242 (S. P. I. Nos. 24555, 24556, 24558, and 24559). Seed from Chardchui." (*Hansen.*)

24558. CALLIGONUM APHYLLUM (Pall.) Guerke.

"(No. 241.) Another species used as a sand binder along the Transcaspian railway. Seed from near Chardchui. See Nos. 133, 240, and 242 (S. P. I. Nos. 24555, 24557, and 24559)." (*Hansen.*)

Distribution.—A native of southern Russia, in the vicinity of the Caucasus Mountains and the Caspian Sea.

24559. CALLIGONUM CAPUT-MEDUSAE Schrenk.

"(No. 242.) Used as a sand binder along the Transcaspian railway. Seed from near Chardchui. Nos. 240, 241, and 242 (S. P. I. Nos. 24557, 24558, and 24559) are all native of the sand deserts of Turkestan. See Nos. 133, 240, and 241 (S. P. I. Nos. 24555, 24557, and 24558)." (*Hansen.*)

Distribution.—A native of the deserts in the region of the Altai Mountains in southern Russia.

24560. PANICUM MILIACEUM L. **Millet.**

"(No. 136.) *'Orenburg red millet,'* grown at Tashkend, Turkestan. May prove to be the same as the *Red Lump Orenburg* millet I introduced from my 1897 trip to Russia. Everything from Orenburg ought to be specially adapted to dry-farming conditions." (*Hansen.*)

24561. PANICUM MILIACEUM L. **Millet.**

"(No. 188.) '*Chinese black millet*' from Tashkend, Turkestan. Appears similar to the lot I obtained in Turkestan in 1897. Afterwards Mr. M. A. Carleton secured the *Black Veronesh* millet. 'Veronesh' appears a better spelling than 'Veronezh.' These large black-seeded millets produce heavily in South Dakota, even when sown late on new breaking, and are useful in stock feeding. The Kirghiz Tartars of northern Turkestan use these and other large-seeded native millets extensively as an important part of their daily diet. For their value in feeding steers, see South Dakota Agricultural Experiment Station Bulletin No. 97, by James W. Wilson and H. G. Skinner." (*Hansen.*)

24562. CICER ARIETINUM L. **Chick-pea.**

"(No. 141.) Chick-pea or 'Persian pea,' from the experiment station at Bairamalee, Turkestan. This is near Merv, a few miles from the Persian border, in ancient Turcomania." (*Hansen.*)

24563. TRITICUM DURUM Desf. **Wheat.**

24564. CICER ARIETINUM L. **Chick-pea.**

"(No. 232.) Native chick-pea as grown at Samarkand, Turkestan." (*Hansen.*)

24565. CICER ARIETINUM L. **Chick-pea.**

"(No. 243.) Another lot of 'Persian peas' or *Garok*, the native name, as grown by the Turcomen in the dry region at Bairmalee, near Merv, Turkestan." (*Hansen.*)

24566. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

"(No. 190.)" *Brown-Eye.*

24567. MEDICAGO SATIVA L. **Alfalfa.**

"(No. 142.) *Turcestanica* alfalfa as bought in the native bazaar at Bairamalee, near Merv, Turkestan. See No. 259 (S. P. I. No. 24811)." (*Hansen.*)

24451 to 24575—Continued.

24568 and 24569. Elaeagnus angustifolia L. **Oleaster.**

24568. "(No. 146.) A cultivated form with edible fruits fully an inch in length, extensively grown in Turkestan. This sample is from Chardchui." (*Hansen.*)

24569. "(No. 238.) Seed of an edible-fruited form, fruit fully an inch long, as grown in Transcaucasia. This lot from bazaar at Tiflis, Transcaucasia." (*Hansen.*)

Distribution.—A native of southern Europe and western Asia, in the region of the Caspian Sea. Cultivated as an ornamental in the United States.

24570. Phaseolus radiatus L. **Green gram.**

"(No. 186.) As grown by the Mohammedans on the northern limits of cotton culture near Tashkend, Turkestan. Used as a catch crop when too late for cotton. The peas are called *Masch* by the natives, and are used for food by them. A promising legume as a cover crop for the cotton belt, and in the dry parts of the Southwest." (*Hansen.*)

24571. Allium sp.

"(No. 191.) An ornamental native onion found in the mountains near Tashkend, Turkestan." (*Hansen.*)

24572. Punica granatum L. **Pomegranate.**

"(No. 235.) Seed of a native variety grown by the native Sarts at Old Bokhara, Turkestan." (*Hansen.*)

24573. Zizyphus sativa Gaertn. **Chinese date.**

"(No. 237.) A sweet fruit from Kutais Province, Transcaucasia, bought in fruit bazaar at Baku." (*Hansen.*)

24574. Pistacia vera L. **Pistache.**

"(No. 239.) Pistache nuts grown in southern Transcaucasia (Armenia) near Persian frontier. This lot is from bazaar at Tiflis, Transcaucasia." (*Hansen.*)

Distribution.—A native of Asia; beginning to be cultivated in California.

24575. Sesamum orientale L. **Sesame.**

"(No. 245.) Seeds raised in the Golodnaya or Hunger steppe, Turkestan. The sesame oil is much liked for table use by the native Mohammedan Sarts. The first oil pressed out is used for the table and in cooking; the rest, with the seeds, is used for the manufacture of *Khalvah*, a favorite Russian and oriental candy. The merits of this sesame oil-cake confection should be investigated by manufacturers in the driest and hottest regions of the United States, as *Khalvah* is certainly a delicious candy, with its fine silk-thread consistency and rich nut flavor. Sesame oil alone will not probably win much favor here, with the abundant and cheap cotton-seed oil. Sesame is an annual and extensively grown in oriental countries." (*Hansen.*)

24576. Punica granatum L. **Pomegranate.**

From Chios, Turkey in Asia. Presented by Mr. N. J. Pantelides. Received January 12, 1909.

Cuttings.

"These pomegranates are not seedless, but the seed is so soft that it can be ground between the teeth without the least difficulty, especially if the fruit is left to ripen long enough on the tree, which needs to be copiously watered." (*Extract from letter of Mr. Pantelides, dated December 24, 1908.*)

24585 and 24586. Vicia spp.

From Erfurt, Germany. Purchased from Haage & Schmidt, at the request of Mr. C. V. Piper. Received January 13, 1909.

Seeds of the following:

24585. Vicia biennis L. (?) **Woolly-pod vetch.**

"This vetch is in most respects very similar to hairy vetch, being nearly, if not quite, as hardy and maturing much earlier." (*Piper.*)

24586. Vicia disperma DC. (?) **Two-seeded vetch.**

"A slender-stemmed erect-growing vetch which has done remarkably well in most of the vetch-growing regions. The stems are very fine and the yield of hay therefore comparatively light, but there is reason to believe that it will maintain itself from year to year in pastures without reseeding." (*Piper.*)

24587. Atalantia hindsii (Champ.) Oliver.

From Hongkong, China. Presented by Mr. S. T. Dunn, superintendent, Botanical and Forestry Department. Received January 14, 1909.

Seeds of a shrub with compressed branchlets, ovate-elliptical leathery leaves, 1½ to 3 inches long, bearing small flowers in axillary clusters, followed by small orange-colored fruits. For citrus breeding experiments.

Distribution.—Found on the wooded hills in the vicinity of Hongkong, China.

24588. Passiflora sp.

From C. Juarez, Chihuahua, Mexico. Presented by Mr. Elmer Stearns, botanist, School of Agriculture, through Mr. Frederic Chisolm. Received January 15, 1909.

Seeds.

"Fruits about the size of a goose egg and orange-yellow when ripe." (*Stearns.*)

24589. Elaeis melanococca Gaertn.

From Cartagena, Colombia, South America. Presented by Mr. Isaac A. Manning, United States consul. Received January 15, 1909.

Seeds of a palm whose stem creeps along the ground and bears a tuft of large pinnate leaves with strong prickly stalks. The flowers are borne in a large head, consisting of numerous little branches bearing minute flowers. The fruits are bright red; the seeds are black.

Distribution.—A native of the primeval woods along the upper branches of the Amazon in the provinces of Para and Rio Negro, Brazil.

24590. Cytisus proliferus Linn. f. **Tagasaste.**

From Teneriffe, Canary Islands. Received from Mr. C. H. Hamilton, through Mr. J. B. Blandy, Funchal, Madeira, January 16, 1909.

"Fodder shrub for light, dry soil; finally grows to 20 feet high, deep rooted, rather intolerant to frost and drought." (*Dyer.*)

"Mr. Hardy, of Adelaide, recommends it as quickly growing for a wind-break. Requires to be periodically cut back, as it otherwise gets too hard for fodder. Very valuable also for apiarists, as flowering during several months, and here during the cool season. In some places it was found that horses and cattle dislike this plant as nutriment. It grows quickly again when cut." (*Von Mueller.*) For previous introductions, see S. P. I. Nos. 2153, 4021, and 7696.

24591. BELOU GLUTINOSA (Blanco) Skeels. (LIMONIA GLUTINOSA Blanco.) (AEGLE DECANDRA Naves.)

From Montalban, Luzon, Philippine Islands. Presented by Mr. William S. Lyon, who collected the seed in December, 1908. Received January 18, 1909.

Seeds.

"A tree, trunk armed with large spines; leaves alternate, ternate; flowers axillary or terminal, whitish. Fruit oblong, 3 inches long, 2 inches thick, surface covered with protuberances and grooved; pulp glutinous, aromatic; juice sour. The wood is used for pillars in houses and the fruit is made into glue. Native names, *Tabog* and *Taboc*." (*Blanco, Flora de Filipinas, 1837.*)

"May be used as a possible stock for dry farming of citrus." (*Lyon.*)

24592. BLIGHIA SAPIDA Konig.

From Ancon, Canal Zone, Panama. Presented by Mr. H. F. Schultz. Received January 18, 1909.

"The 'Akee,' a beautiful African tree introduced into the West Indies. Valued in Jamaica as a richly flavored and wholesome food. The bright-yellow, fleshy arillus is the part eaten. Should not be eaten if in the *least* decayed. The fruit is prepared in various ways, stewed in milk and afterwards browned in a frying pan with butter. It is also commonly eaten boiled and mixed with salt fish, onions, and tomatoes as a breakfast food." (*Extract from Cook and Collins, "Economic Plants of Porto Rico."*)

24593 to 24595.

From Miami, Fla. Received through Mr. P. J. Wester, in charge of Subtropical Garden, January 16, 1909.

The following seeds:

24593. THRINAX FLORIDANA Sarg.

"This is indigenous to southern Florida and the keys, with slender trunk, attaining a height of 25 or more feet, with crown of small diameter; the leaves are green above and silvery white beneath; the berries are produced in great abundance and are waxy white. This palm might make a very satisfactory subject for the conservatory, where, as far as I am aware, it has never been tried, and is worth introducing into southern California and Hawaii. I have no doubt it is indigenous to Porto Rico." (*Wester.*)

24594. COCCOTHRINAX GARBERI (Chapm.) Sarg.

"This is a dwarf palm with rather slender stem; leaves yellowish green, lustrous above, silvery beneath; the berries are deep purple. This also might make a very attractive greenhouse subject, and is certainly worth introducing into southern California and Hawaii." (*Wester.*)

Distribution.—Found on dry coral ridges near the shore of Biscayne Bay, Florida.

24595. JACQUEMONTIA PENTANTHA (Jacq.) G. Don.

An attractive greenhouse climber for summer and autumn flowering, with rich violet-blue flowers. (*Adapted from Bailey.*)

Distribution.—Florida keys and Tropical America.

24596. MEDICAGO DENTICULATA Willd. **Bur clover.**

From Chico, Cal. Grown at the Plant Introduction Garden by Mr. Roland McKee from seed collected near Tanghsiang, Shansi, China, by Mr. Frank N. Meyer, agricultural explorer, April 30, 1907; received at the Plant Introduction Garden June 15, 1907, under his number, 727a. Received at Washington, D. C., and numbered for convenience in recording distribution, January 14, 1909.

"A leguminous perennial, probably a bur clover, found growing between rocks. May be of use on dry sterile soils as a fodder plant. Only found in one locality and only a few plants to be found there." (*Meyer.*)

24598. MEDICAGO SATIVA L. **Alfalfa.**

From Yuma, Ariz. Received through Mr. Charles J. Brand, January 19, 1909.

"Seed of Andean alfalfa, propagated from the original importation No. 9303. In the production of this seed the method of planting transplanted crowns, which appears to be fairly common in South America, but which has not, so far as known, been used in this country, was employed. Within five months from time of transplanting the crowns, which were taken from a 3-year-old stand, mature seed was produced. Almost 75 pounds of seed were taken from about one-fourth of an acre, with the plants 3 feet apart each way. The general use of this method is suggested when it is desired to plow up old fields which have become unprofitable because of the thinness of the stand." (*Brand.*)

24599. PISUM SATIVUM L. **Pea.**

From Paris, France. Purchased from Vilmorin-Andrieux & Co. Received January 16, 1909.

Tall Butter Sugar.—"A variety distinguished by fleshy and fiberless pods that can be used in the same way as string beans. An old variety in Europe, but rarely grown, thus far, in America." (*W. W. Tracy, sr.*)

24600. DIOSPYROS EBENASTER Retz.

From Guadalajara, Mexico. Presented by Señor Luis Rosas, through Mr. Frederic Chisolm. Received January 21, 1909.

"The *Zapote Prieto* of Mexico. A persimmon with large, delicious, and delicate fruits, the flesh of which looks curiously like axle grease. Properly a tropical tree, but capable of withstanding light frosts when it forms a low tree with bright, glossy green leaves, 15 to 25 feet high. In frostless regions it reaches a height of 60 to 70 feet. Fruits too soft to stand long shipment. Should succeed in southern Florida and southern California." (*Chisolm.*)

Distribution. A native of the Philippine Islands and the Celebes. Cultivated in Mauritius, Calcutta, and Malacca. Occurs also in cultivated places in Tropical America: Orizaba, Vera Cruz, Cuernavaca, Lizaro, Miradon, and Cordova, in Mexico; Rio Janeiro in Brazil; and in Cuba.

24601. CAJAN INDICUM Spreng.

From Huradura, Cuba. Presented by Prof. F. S. Earle, through Prof. S. M. Tracy, Biloxi, Miss. Received January 20, 1909.

24602 and 24603. MEDICAGO spp.

From Germany. Secured by Mr. G. Schulze, civil engineer, Altenkirchen, Westerwald, Germany, and presented by Mr. Paul Schulze, Chicago, Ill., through Mr. Charles J. Brand. Received January 22, 1909.

Seeds of each of the following:

24602. MEDICAGO SATIVA L. **Alfalfa.**

Provence. From Bonn, Germany. (P. L. H. No. 3352.)

24603. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

From Erfurt, Germany. (P. L. H. No. 3353.)

24604. CAJAN INDICUM Spreng.

From Little River, Fla. Presented by Mr. E. J. Andrews, through Mr. P. J. Wester, in charge of Subtropical Garden, Miami, Fla. Received January 22, 1909.

"(S. G. No. 1169.) This plant is similar in habit and appearance to the ordinary pigeon pea, except that the standard of the corolla is streaked with deep orange-red, while the ordinary species in cultivation here is pale lemon-yellow; it differs also in that the plant blooms early in the fall and the seed ripens by Christmas or a little later, while the ordinary pigeon pea is still in bloom and will not ripen its seed for a month more at least. The pigeon pea is useful in poultry yards, where the chickens crack the pods and eat the peas. This variety would be useful, as it ripens earlier than the ordinary variety, and would probably be of interest to the people in Hawaii, Porto Rico, and the Canal Zone. The seed from which Mr. Andrews's plants grew came from Nassau, Bahama." (*Wester.*)

24605 to 24607. TRITICUM AESTIVUM L. **Wheat.**

From Smyrna region, Turkey. Presented by Mr. H. Caramañian, Amasia, Turkey, at the request of Mr. M. A. Carleton. Received January 23, 1909.

Seeds of each of the following:

24605. "*Red black awned.*"

24606. "*Yellow Poussana.*"

24607. "*White Poussana.*"

24608. ROSA sp. **Rose.**

From Guadalajara, Jalisco, Mexico. Presented by Señor Severo Hernandez, through Mr. Frederic Chisolm. Received January 26, 1909.

"The 'rosa rellena' of the Mexicans, a healthy, strong-growing variety with flowers as large and perhaps better formed than those of the American Beauty, rather darker in color and not so fragrant." (*Chisolm.*)

24609. GLYCOSMIS PENTAPHYLLA (Retz.) Correa.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Botanic Garden. Received January 27, 1909.

Variety *dilatata.* An unarmed shrub with evergreen compound leaves of one to five leaflets. The small, white, fragrant flowers are borne in panicles. The berries are white, globose, varying from the size of a pea to that of a cherry.

Distribution. Throughout tropical and subtropical Himalaya, ascending to 7,000 feet in Sikkim; also in southern China, in the Philippines, and in northeastern Australia.

24610. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Trenton, Ky. Purchased from Mr. S. J. Leavell. Received January 6, 1909.

Trenton. "A brown-seeded variety picked out of *Mammoth* by Mr. Leavell in 1904, and in that year 12 plants produced 7 pounds of seed; in 1905 these 7 pounds produced 10 bushels; in 1906 Mr. Leavell reports that with exactly the same treatment it outyielded *Mammoth* by 50 per cent. Seems like a promising variety." (*H. T. Nielsen.*)

24612. MEDICAGO FALCATA L.

From Babb, Mont. Grown by Mr. C. L. Bristol and received from him January 18, 1909.

Grown from S. P. I. No. 20718.

24613. SOLANDRA GRANDIFLORA Swartz.

From Guadalajara, Jalisco, Mexico. Presented by Señor Severo Hernandez, through Mr. Frederic Chisolm. Received January 26, 1909.

"Cuttings of 'Guayacan' or 'Copa de oro,' an ornamental hard-wood climber, with smooth, bright-green leaves and very large gold-colored flowers. Very ornamental in every way, but not suited for outdoor cultivation except in frostless sections." (*Chisolm.*)

Distribution.—A native of Jamaica and of Mexico, extending north to Cordova; also south through Guatemala, Nicaragua, and Colombia to Brazil.

24614 to 24619.

From Antigua, British West Indies. Presented by Mr. A. S. Archer, through Mr. P. J. Wester, in charge of Subtropical Garden. Received January 28, 1909.

Seeds of each of the following:

24614. HYDRIASTELE WENDLANDIANA (Muell. & Moore) Wendl. & Drude.

(S. G. No. 1175.) *Distribution.*—A native of the northern coast of Australia.

24615. THRINAX BARBADENSIS Lodd.

(S. G. No. 1177.) *Distribution.*—A native palm of the island of Barbados in the British West Indies.

24616. CARYOTA MITIS Lour.

(S. G. No. 1178.) *Distribution.*—A native palm of southeastern Asia, extending from Burma and the island of Hainan southward through the Malay Archipelago.

24617. THRINAX MORRISII Wendl.

(S. G. No. 1179.) *Distribution.*—A dwarf palm found in Anguilla Island in the British West Indies.

24618. THRINAX RADIATA Lodd.

(S. G. No. 1180.) *Distribution.*—A native palm on the island of Trinidad and also found in Cuba.

24619. ABRUS PRAECATORIUS L.

(S. G. No. 1176.) "A cream-colored variety of this twining vine." (*Archer.*)

Distribution.—A native of the Himalaya Mountains, ascending to 3,500 feet, and of Ceylon and Siam. Cultivated generally throughout the Tropics; used in the southern part of the United States for covering screens.

24620 to 24630.

A collection of conifer seeds secured for foreign exchange and for cooperative hybridizing experiments with Mr. J. W. Riggs, Waterloo, Kans.

24620. PINUS MURICATA D. Don.

From Fruitvale, Cal. Purchased from Mr. F. A. Miller. Received January 28, 1909.

Distribution.—California coast region from Mendocino County southward, usually in widely separated localities, to Tomales Point, north of the Bay of San Francisco, and from Monterey to San Luis Obispo County; in Lower California on Cedros Island, and on the coast between Ensenado and San Quintan.

24621 to 24629.

Received through the Forest Service, United States Department of Agriculture, Washington, D. C., January and February, 1909.

24621 to 24623. Collected in Crook National Forest, Arizona, at an altitude of approximately 6,000 feet.

24621. JUNIPERUS PACHYPHLAEA Torr.

Distribution.—Dry, arid mountain slopes, usually at elevations of 4,000 to 6,000 feet above the sea, from the Eagle and Limpio mountains in southwestern Texas, westward along the desert ranges of New Mexico and Arizona, south of the Colorado plateau, extending northward to the lower slopes of many of the high mountains of northern Arizona and southward into Mexico.

24622. JUNIPERUS MONOSPERMA Sarg.

Distribution.—Along the eastern base of the Rocky Mountains from the divide between the Platte and Arkansas rivers in Colorado to western Texas, southern New Mexico, and Arizona and southward into northern Mexico.

24623. PINUS EDULIS Engelm.

Distribution.—Eastern foothills of the outer ranges of the Rocky Mountains, from Colorado to western Texas, westward to the eastern border of Utah, southwestern Wyoming, northern and central Arizona, and over the mountains of northern Mexico.

24624 and 24625. Collected in Chiricahua National Forest, Arizona.

24624. JUNIPERUS PACHYPHLAEA Torr.

From an elevation of 5,000 feet. See No. 24621 for distribution.

24625. CUPRESSUS ARIZONICA Greene.

From an elevation of 5,500 feet.

Distribution.—Found on the mountains of central, eastern, and southern Arizona, often on the northern slopes forming almost pure forests of considerable extent at elevations of 5,000 to 6,000 feet above the sea; also found on the mountains of northern Sonora and Chihuahua, in Mexico.

24626. PINUS PONDEROSA Laws.

Collected in Coconino National Forest, Arizona.

Distribution.—A large tree of the western part of North America, extending from British Columbia to Lower California and northern Mexico and eastward as far as northwestern Nebraska and western Texas.

24620 to 24630—Continued.

24621 to 24629—Continued.

24627. PICEA ENGELMANNI (Parry) Engelm.

From Gallinas Cañon, Pecos National Forest, New Mexico. Altitude, approximately 7,800 feet.

Distribution.—A native tree of the high mountain slopes of western North America, extending from Alberta and British Columbia to New Mexico and Arizona, from an elevation of 5,000 feet in the north to 11,500 feet in the south.

24628. PSEUDOTSUGA TAXIFOLIA (Lamb.) Britt.

Collected in Carson National Forest, New Mexico, at an altitude of approximately 7,500 feet.

Distribution.—From about latitude 55° north in the Rocky Mountains and from the head of the Skeena River in the Coast Range southward through all the Rocky Mountain system to the mountains of western Texas, southern New Mexico, southern Arizona, and northern Mexico.

24629. PICEA ENGELMANNI (Parry) Engelm.

Collected in Alamo National Forest, New Mexico, at an altitude of approximately 9,000 feet. See No. 24627 for distribution.

24630. PINUS CARIBAEA Morelet.

From Miami, Fla. Received through Mr. P. J. Wester, in charge of Subtropical Garden, January 4, 1909.

Distribution.—A native of the southeastern coast of North America, from South Carolina to the highlands of Central America, and of the Bahamas and the Isle of Pines.

24631. GOURLIEA SPINOSA (Mol.) SKEELS. (LUCUMA SPINOSA Mol., 1782.) (GOURLIEA CHILENSIS Gay, 1846.)

From Nice, France. Presented by Dr. A. Robertson Proschowsky. Received January 28, 1909.

Seed of the Chañal, a small tree 12 to 15 feet high, with long, thick, cylindrical branches, ending in spines. The leaves are compound, consisting of three pairs of small ovate leaflets. The flowers, borne in short, loose racemes, are orange-yellow, streaked with red. The fruit is about 1 inch in diameter, covered with a brownish skin and having a pulp resembling a jujube (Chinese date) in flavor. The wood is yellow, quite hard, and used considerably by cabinetmakers.

Distribution.—This tree grows along hedges in the provinces of Coquimbo, Copiapo, Tambo, and Guanta in Chile at an elevation of 1,500 to 5,000 feet.

24635. MEDICAGO SATIVA L. **Alfalfa.**

From Boxberg, Baden, Germany. Secured from the Getreidelagerhaus, Boxberg, through Mr. Charles J. Brand. Received January 27, 1909.

Alt-Deutsche Fränkische lucern. "This seed was grown in the same region as No. 22467, under which number a detailed account is given. It is of special interest on account of the fact that it comes from within 15 or 20 miles of the original home of the well-known *Grimm* alfalfa of Minnesota." (*Brand.*)

24636. MANGIFERA INDICA L. **Mango.**

From Papeete, Tahiti, South Sea Islands. Presented by Mr. Barbour Lathrop. Received January 30, 1909.

"This is a tiny, rich-flavored mango, very different from any I have ever seen, not much larger than a very big English walnut. There is only one tree on the island, and no one can tell me where it came from. The fruits from which these seeds were taken were about the size of a large plum and very delicate in taste." (*Lathrop.*)

24637. MASCARENHASIA ELASTICA K. Schum.

From Mozambique, Portuguese East Africa. Presented by Mr. O. W. Barrett, Director of Agriculture, Lourenço Marquez. Received February 1, 1909.

"(No. 22.) Seed of a shrubby tree 20 to 30 feet high. Wild in hinterland of Mozambique Company's territory. Rubber of about same quality as *Landolphia kirkii*. Mr. W. H. Johnson, the agronomist of the Mozambique Company, thinks the species a rather valuable discovery. It grows with *Landolphia kirkii* and the rubber exported through Beira probably consists of the two gums mixed." (*Barrett.*)

Distribution.—A native of the woods of German East Africa, in the vicinity of Dar-es-Salaam and Mbaffu.

24638. ILEX CORNUTA Lindl. and Paxt.

From 75 or 100 miles northwest of Shanghai, China. Presented by Rev. J. M. W. Farnham, Chinese Tract Society, Shanghai, China. Received January 30, 1909.

Distribution.—A native of China, being found at Shanghai and Chinkiang in the province of Kiangsu; at Ningpo and Kiangsi in the province of Chekiang; and at Ichang in the province of Hupeh.

24639. PHASEOLUS SEMIERECTUS L.

Grown at Biloxi, Miss., in 1908, by Mr. S. M. Tracy, special agent. Received January, 1909.

"Original seed from Cuba, where the plant is valued highly as a semivolunteer cover crop in orange groves. Flowers are in spikes which continue to grow indefinitely, so that ripe seed and fresh flowers occur on the same stem, which makes seed gathering slow work." (*Tracy.*)

24640. SAPIUM VERUM Hemsley. **Virgin rubber.**

From Chaparral, Tolima, Colombia, South America. Purchased from Mr. Andres Rocha. Received February 2, 1909.

"*Caucho virgen* (Tolima). *Caucho blanco* (Cauca). Seeds of the Tolima (virgin) rubber tree, once common in the forests of the upper valleys of the Magdalena basin in Colombia, but to-day scarcely seen in its wild state and seldom cultivated. It grows in a temperate, almost cold but equable climate, between 1,800 and 3,200 meters of altitude, in such conditions of soil and general environment as to make the possibility of its acclimatization in Florida appear very doubtful. It might be tried with better prospects of success in the upper forest zone of the Philippine Islands, as well as in Hawaii and Porto Rico. When cultivated in its own country it thrives splendidly. Trees 8 to 10 years old are expected to yield annually from 1 to 3 kilograms of rubber of very high quality, second only to the best Para. One individual 14 years old seen at Tocotá, near Calé, Colombia, measured 65 centimeters in diameter and 50 meters in height. The tree flowers for the first time when about 3 years old. As far as is known, the only way of obtaining a full yield of the latex is to fell the trees, the average product being from 5 to 8 kilograms of raw rubber to each tree. This method is generally applied to the wild trees, which explains the rapid disappearance of the species." (*H. Pittier.*) See also S. P. I. Nos. 3820 and 3948.

24641 to 24643. Glycine hispida (Moench) Maxim. **Soy bean.**

From Taihoku, Formosa. Presented by Mr. I. Kawakami. Received January 21, 1909.

The following seeds:

24641. Cream-yellow.

24642. Black, small.

24643. Black, very small.

24644 to 24648.

From Australia. Presented by Mr. B. Harrison, Burringbar, Tweed River, New South Wales, Australia. Received February, 1909.

Seeds of each of the following (quoted common names given by Mr. Harrison):

24644. Chloris ventricosa R. Br.

"Australian grass."

Distribution.—A native grass of the southeastern part of Australia, being found in Queensland and New South Wales.

24645. Eragrostis lacunaria F. Muell.

"Australian never-fail grass."

Distribution.—A native grass of the southeastern part of Australia, being found in the valley of the Barcoo River in Queensland, in the valley of the Murray River, and in the vicinity of Lake Eyre, in South Australia.

24646. Panicum muticum Forsk.

"Giant Couch. Twenty tons per acre. North Queensland."

Distribution.—A native grass of the northern part of Egypt, and cultivated or adventitious generally throughout the Tropics.

24647. Paspalum quadrifarium Lam. (?)

"Brazilian grass."

Distribution.—A grass native of the southern part of South America, being found in the low valleys and along shores in southern Brazil, northern Argentina, and in Uruguay.

24648. Sporobolus argutus (Nees) Kunth.

"Brazilian mountain grass."

Distribution.—A Brazilian grass found in the province of Piauhy and in the valley of the San Francisco River.

24650 and 24651. Solanum spp.

From Mayaguez, Porto Rico. Presented by Mr. D. W. May, special agent in charge, Agricultural Experiment Station. Received February 3, 1909.

Seeds of the following:

24650. Solanum mammosum L.

"*Berengena de marimbo.*" "A large-fruited wild species used as a stock on which to graft the cultivated varieties of eggplant. The handsome yellow fruits are reputed to be poisonous." (*Frederic Chisolm.*)

Distribution.—A native of southern Mexico, extending from the region of Orizaba south through Nicaragua, Panama, Colombia, and Guiana; also in the West Indies.

24650 and 24651—Continued.

24651. Solanum torvum Swartz.

"*Berengena cimarrona.*" "A very small-fruited variety." (*Frederic Chisolm.*)

Distribution.—Throughout Central America, extending north to San Luis Potosi, Mexico, where it is found at an elevation of 8,000 feet; also commonly found throughout India in the tropical region and in the Malay Archipelago, the Philippines, and in China.

24652. Citrus aurantium sinensis L. **Sweet orange.**

From Blida, Algeria. Presented by Dr. L. Trabut, government botanist, Mustapha-Alger, Algeria. Received February 5, 1909.

Seeds:

"White orange of Blida." (*Revue horticole.*)

"Tall tree, dark green, spiny, fruits large and abundant, pale-lemon color, flesh very pale color, fine, very juicy. Rare variety of seedling at Blida, more robust than the white orange of Teneriffe. January to April." (*Trabut.*)

24653. Amygdalus persica L. **Peach.**

From Canton, China. Presented by Mr. G. W. Groff. Received February 5, 1909.

Scions.

Ying tsui to.

24654 to 24656. Fragaria chiloensis (L.) Duchesne. **Strawberry.**

From Chile. Received through Mr. José D. Husbands, Limávida, Chile, February 5, 1909.

The following seeds:

24654. "Light-red class, prolific, hardy, acid sweet, good flavor, ripens quickly and becomes soft; bad shipper." (*Husbands.*)

24655. "White class, mixed; fine flavor, extra firm flesh, very large size, extra prolific, early and quick ripener, hardy, good shipper, thrives in the worst soils (clays) with little moisture. Fine sort to work on as a base for selections." (*Husbands.*)

24656. "White class, same fruit as S. P. I. No. 24655 with the exception that they are uniform in size and shape, fruit somewhat smaller, some of which have a pale-pink tint scattered at the top." (*Husbands.*)

Distribution.—A native of the Pacific slope of America extending from Alaska to Patagonia; also found in the Sandwich Islands.

24657. Stizolobium sp.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Department of Agriculture. Received February 8, 1909.

24658. Andropogon barbinodis Lag.

From Chico, Cal. Grown at the Plant Introduction Garden by Mr. Roland McKee from seed procured from the Wagga Experimental Farm, New South Wales, Australia, in 1904, under Agrostology No. 2293. Received February, 1909.

Distribution.—A native of the southwestern part of the United States, extending into Mexico.

24659. PISTACIA CHINENSIS Bunge. Pistache.

From Laotanchuang, Shantung, China. Collected by Mr. Henry S. Cousins, Taianfu, Shantung, China, forwarded through Mr. Ernest Vollmer, vice-consul, Tsingtau, China. Received February 8, 1909.

"*Description and habitat.*—*Pistacia chinensis* (Chinese name 'Huang lien shu'). Seed of a deciduous, diœcious tree, growing 40 to 50 feet tall, with a trunk 4 to 5 feet in diameter, of spreading habit, bearing large, pinnated leaves which are of a wine-red when budding out, of a vivid, glossy green in summer, and changing into flaming scarlet and yellow in the fall. The pistillate trees bear heavy bunches of small berries, which are green at first, turn into red later on, but assume a bluish green color when ripe. The seeds are not edible, but they yield an illuminating oil in small quantities. This wild Chinese pistache looks strikingly like a gigantic sumac, and will be appreciated as a new shade and ornamental tree, especially in the semiarid mild-wintered regions of the United States. I observed in China that the male trees were invariably larger than the females and were also handsomer trees.

"Strong hopes are held that the Chinese pistache may supply a suitable stock for the *Pistacia vera*, which produces the celebrated pistache nuts of commerce and for which hardier, more easily handled stock is needed." (*Meyer.*) For fuller notes and photographs, see "Ornamental Horticulture in China," by Frank N. Meyer.

"Until Mr. Meyer secured the Chinese pistache the only hardy stock available was the *Pistacia terebinthus* L. of southern Europe, of which it has proved impossible to secure any considerable quantities of seed. The Chinese species, however, bids fair to be superior to it in every respect, as it is hardier, grows more rapidly, and reaches a larger size. It is the hardiest known species of the pistache (see S. P. I. No. 10285), and Mr. Meyer's investigations have shown that it grows to very large size and is in fact the largest species of the section to which *Pistacia terebinthus* belongs. The latter is the stock upon which a large part of the high-priced Sicilian pistaches are grown, so it is highly probable that the Chinese pistache will prove satisfactory as a stock upon which to work the improved varieties of *Pistacia vera.*

"Although this Chinese pistache was introduced into Europe from Central China some forty years ago and a plant of it is still growing in the Botanic Garden at Paris, it remained a botanical curiosity until Mr. Meyer secured scions and seed from northern China, where the winters are more rigorous than in any other part of the world where pistaches grow wild.

"Large numbers of Chinese pistache seedlings have been grown at the Plant Introduction Garden, Chico, Cal., from seed secured by Mr. Meyer. The young plants have proved to be of remarkably rapid growth, decidedly more rapid than any other stock tested as yet." (*Swingle.*) For further remarks, see S. P. I. Nos. 10285, 17734, 17735, 18272, 18273, 18605, 19391, and 21970.

24661 to 24665. ANONA CHERIMOLA Mill.

From Chile. Received through Mr. José D. Husbands, Limávida, Chile, February 5, 1909.

The following seeds:

24661. *Lisa*, or large smooth-skin class.

24662 and 24663. "*Púas*, meaning graft. I am not aware why this variety is called *Púas*." (*Husbands.*)

24664 and 24665. "*De Concha*, meaning shell. The fruit is so called on account of its having a rough surface; other varieties with rough, warted, uneven surfaces are also called 'Rugoso' and 'Escamosa' (scaly like an oyster shell)." (*Husbands.*)

Distribution.—A native of America, extending from Chile north through Peru and Central America to the region of Orizaba, Mexico. Cultivated in Florida and in Italy and Algeria.

24667. MEDICAGO SATIVA L. **Alfalfa.**

From Iphofen, Bavaria, Germany. Secured from the Saatzucht Verein für fränkische Luzerne in Iphofen, Bavaria, through Mr. Charles J. Brand. Received February 8, 1909.

Alt-Deutsche Fränkische lucern. "(P. L. H. No. 3355.) This old-land race received its name from the circles of Franconia in northern Bavaria, where it has been grown many years. In the vicinity of Iphofen three to four cuttings of hay are secured each year. The seed is produced by the second crop." (*Brand.*)

24668. MEDICAGO SATIVA L. **Alfalfa.**

From Germany. Secured by Herr Carl Bodenstein, Osterode am Harz, Germany, and presented by Mr. Paul Schulze, Chicago, Ill., through Mr. Charles J. Brand. Received January 30, 1909.

(P. L. H. No. 3356.)

24671. CHAYOTA EDULIS Jacq. **Chayote.**

From Los Angeles, Cal. Presented by Mr. M. E. Cheney. Received February 15, 1909.

A small, smooth variety, secured for cooperative work with the State Experiment Station, Baton Rouge, La.

Distribution.—A native of tropical South America, Central America, and Mexico, where it extends northward to the province of Chihuahua. Cultivated in California, and Florida and in southern Spain and Algeria.

24672 to 24711.

From India. Presented by J. Mollison, esq., M. R. A. C., Inspector-General of Agriculture in India, Nagpur, C. P. Received February 10, 1909.

The following seeds (quoted notes by Mr. Mollison; descriptions of varieties by Mr. H. T. Nielsen):

24672 to 24690. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

24672. "*Rymbai-ktung.* From Khasi Hills, Assam."

Similar to No. 18258a.

24673. "*Bhatumsh* (red). From Darjeeling, Assam."

Light-chocolate color, looks like No. 17852c, which is a selection from *Meyer*, No. 17852.

24674. "*Bhatumsh* (yellow). From Darjeeling, Assam."

Straw-yellow with brown hilum.

24675. "*Bhatwas.* From Safipur, Unao, U. P."

Black, small seed about the same size as *Cloud*, but rather more dull in color.

24676. "*Bhatwas.* From Hasangani, Unao, U. P."

Black, looks like No. 24675, only seeds are shiny like *Cloud*.

24677. "*Bhatwas.* From Ranjitpurwa, Unao, U. P."

Black, just like No. 24676, only seeds are a trifle smaller.

24678. "*Chabeni khurti* (spotted variety). From Hardupurwa, Teh-Bidhanna, Etawah, U. P."

24679. "*Chabeni khurti* (black variety). From Bant, Teh, Sadar, Etawah, U. P."

24672 to 24711—Continued.

24672 to 24690—Continued.

24680. "*Chabeni khurti* (black variety). From Atsu, Teh, Auraya, Etawah, U. P."

24681. "*Bhatwas* (mixture of spotted and black). From Mainpuri, U. P."

24682. "*Kali khurti*, *Chabeni khurti*, *Khajwa*. From Mainpuri, U. P."

24683. "*Chabeni khurti* (black variety). From Kilerman. Teh, Sadar, Etawah, U. P."

24684. "*Chabeni khurti* (black variety). From Amapur, Teh, Kasaganj, Etawah, U. P."

24685. "*Chabeni khurti* (black variety). From Aliganj, Etawah, U. P."

24686. "*Chabeni khurti Bhundadar* (spotted variety). From Jalesar, Etawah, U. P."

24687. "*Khajwa* or *kulthi*. From United Provinces."

24688. "*Bhatwas*. From Cawnpore, U. P."

24689. "*Bhatwas*. From Nanbasta, Cawnpore, U. P."

The preceding S. P. I. Nos. 24678 to 24689 are black, with small seed, about the size and shape of S. P. I. No. 20410. There is some slight variation in the size of the seed, but the entire lot might easily be taken for the same variety if judged by the seed only.

24690. "*Bharat Safed*. From Dehra Dun, U. P."

Similar to S. P. I. No. 22901.

24691 and 24692. Dolichos biflorus L.

Distribution.—A leguminous vine, native in India, from the Himalayas to Ceylon and Burma, occurring at elevations of 3,000 feet in Sikkim; also found generally throughout the Tropics of the Old World, being cultivated in some places.

24693 to 24711. Glycine hispida (Moench) Maxim. **Soy bean.**

Japanese varieties of soy beans grown on Poona Farm, Bombay Presidency.

24693. Straw-yellow, with rather an indistinct hilum, quite similar to *Manhattan*, S. P. I. No. 17277.

24694. Straw-yellow, very similar to S. P. I. No. 24693; seeds may be a trifle larger.

24695. Straw-yellow, seed very similar to *Ito San*, but the brown speck at end of hilum is very faint.

24696. Just like above, S. P. I. No. 24695.

24697. Similar to S. P. I. No. 20405.

24698. Olive-yellow, very similar to No. 20893a.

24699. Straw-yellow, seed about the size of S. P. I. No. 17269.

24700. Pale straw-yellow, with a black hilum; seed about the size of *Acme*, S. P. I. No. 14954.

24701. Dirty olive-yellow, with slate-colored hilum; seed about the size of *Ito San* but more globular.

24702. Straw-yellow, with very faint hilum; similar to *Butterball*, S. P. I. No. 17273, but seed rather smaller and not so bright in color.

24672 to 24711—Continued.

24693 to 24711—Continued.

24703. "*Oylan Dai Dizen.*"

Straw-yellow, very similar to *Okute*, S. P. I. No. 19986.

24704. "*Gosha Dai Dizen.*"

Very similar to S. P. I. No. 24700.

24705. Light shade of chromium-green, similar in appearance to S. P. I. No. 17857, but the color is not quite the same.

24706. Black. Apparently just like our *Buckshot*, S. P. I. No. 17251.

24707. "*Kuru Maru.*"

Apparently just like *Nuttall*, S. P. I. No. 17253.

24708. "*Sirohaha.*"

Apparently just like *Butterball*, S. P. I. No. 17273.

24709. "*Teppo.*"

Citron-yellow, seeds about the size of *Butterball*.

24710. "*Motonari.*"

Seed very similar to S. P. I. Nos. 24700 and 24704, but the hilum is russet in this case.

24711. "*Rokugatsu.*"

Citron-yellow, with very faint hilum, seed about the size and shape of *Mammoth*.

24712. CHAMAECYPARIS NOOTKATENSIS (Lamb.) Spach.

Yellow cedar.

From Cholmondeley Sound, Prince of Wales Island. Collected by Ranger Babbitt and presented by Mr. W. A. Langille, forest supervisor, Ketchikan, Alaska. Received February 15, 1909.

For use in foreign exchanges.

Distribution.—A native tree of the northwestern part of North America, extending from southern Alaska southward through British Columbia and the Cascade Mountains of Washington and Oregon to the valley of the Santiam River.

24713 and 24714.

From Harrar, Abyssinia. Presented by Mr. T. Gerolimato, through Mr. Hubert S. Smiley, Drumalis, Larne, County Antrim, Ireland. Received February 16, 1909.

Seeds of each of the following:

24713. RHAMNUS PRINOIDES L'Herit.

"This plant is called *Gheisho*, not *Geaho*, and grows by preference on the hills; it reaches a height of 10 to 12 feet. The leaves are never added to the *tieff* [made of the seeds of *Eragrostis abyssinica*], but only to the *tedj* (the hydromel), which consists of one part of honey and two parts of water; then the leaves of *Gheisho* are added to hasten the fermentation." (*Gerolimato.*)

Distribution.—A shrub or small tree, native of Abyssinia in East Africa and also of extratropical South Africa, extending to the Cape of Good Hope.

24713 and 24714—Continued.

24714. Catha edulis Forsk.

"*Kiat* is a small tree, reaching the height of 10 to 15 feet; it grows in good red soil and by preference on hills in Arabia. There is only one kind, no varieties. The natives masticate the leaves of the tree; the new and tender leaves are of course preferred. It is a narcotic, and some say that it is also an aphrodisiac, like the hashish. The natives do not smoke it like opium. I am afraid the *Kiat* is propagated only by cuttings and not by seeds." (*Gerolimato.*)

Distribution.—A native shrub of Abyssinia and Arabia, cultivated to a large extent for its leaves.

24715 and 24716. Citrus spp.

From Cochin China. Presented by Mr. Jacob E. Conner, United States consul, Saigon, Cochin China. Received February 16, 1909.

Seeds of the following:

24715. Citrus nobilis Lour.

"Annamite. *Cam-Sanh* grows particularly well at Cai-be, near here (Saigon). The skin is green and almost as loose as the skin of a mandarin orange. I think it as good an orange as I ever ate—splendid, and about the size of a Florida orange." (*Conner.*)

24716. Citrus aurantium L. **Orange.**

"*Cam-Mat* is a tight-skinned fruit, yellowish green when ripe, very good to eat, but awkward to handle. On every account I would prefer the above (S. P. I. No. 24715)." (*Conner.*)

24717 to 24741. Medicago spp.

From Dahme, Mark Brandenburg, Germany. Secured by Oberlehrer C. von Stoeltzer, of the agricultural school at Dahme, and presented through Mr. Charles J. Brand. Received February 13, 1909.

The following seeds of regional strains of alfalfa, with the German common names:

24717 to 24736. Medicago sativa L. **Alfalfa.**

24717. *Böhmische* lucern. (P. L. H. No. 3359.)
24718. *Mährische* lucern. (P. L. H. No. 3360.)
24719. *Ungarische* lucern. (P. L. H. No. 3361.)
24720. *Provencer* lucern. (P. L. H. No. 3362.)
24721. *Süd-Französische* lucern. (P. L. H. No. 3363.)
24722. *Nord-Französische* lucern. (P. L. H. No. 3364.)
24723. *Südliche Russische* lucern. (P. L. H. No. 3365.)
24724. *Nordliche Russische* lucern. (P. L. H. No. 3366.)
24725. *Spanische* lucern. (P. L. H. No. 3367.)
24726. *Turkestanische* lucern. (P. L. H. No. 3368.)
24727. *Deutsche Luzerne aus Baden.* (P. L. H. No. 3369.)
24728. *Deutsche Luzerne aus Baden.* (P. L. H. No. 3370.)
24729. *Ungarische* lucern. (P. L. H. No. 3371.)
24730. *Süd-Russische* lucern. Naturell. (P. L. H. No. 3372.)
24731. *Süd-Russische* lucern. Gereinigt. (P. L. H. No. 3373.)
24732. *Russische Luzerne—Nord-Russische.* (P. L. H. No. 3374.)

24717 to 24741—Continued.

24717 to 24736—Continued.

24733. *Alt-Fränkische* lucern. (P. L. H. No. 3375.)

24734. *Provencer* lucern. (P. L. H. No. 3376.)

24735. *Italienische* lucern. (P. L. H. No. 3377.)

24736. *Spanische* lucern. (P. L. H. No. 3378.)

24737. MEDICAGO SATIVA VARIA (Mart) Urb. **Sand lucern.**

Böhmische sand lucern. (P. L. H. No. 3379.)

24738 to 24740. MEDICAGO SATIVA L. **Alfalfa.**

24738. *Turkestanische* lucern. (P. L. H. No. 3380.)

24739. *Turkestanische* lucern. (P. L. H. No. 3381.)

24740. *Nord-Italienische* lucern. (P. L. H. No. 3382.)

24741. MEDICAGO SATIVA VARIA (Mart) Urb. **Sand lucern.**

Böhmische sand lucern. (P. L. H. No. 3383.)

24742. CAJAN INDICUM Spreng.

From Biloxi, Miss. Grown by Prof. S. M. Tracy, special agent. Received February 16, 1909.

"Purple seed. Original seed from Cuba. Not as early as S. P. I. No. 24601." (*Tracy.*)

24753 to 24755.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Department of Agriculture. Received February 19, 1909.

The following seeds:

24753. ATALANTIA BILOCULARIS (Roxb.) Wall. (LIMONIA BILOCULARIS Roxb.)

For use in citrus breeding work.

Distribution.—A native of the southeastern part of China, extending to the islands of Hainan and Formosa.

24754. NEPHELIUM MUTABILE Blume.

Distribution.—A native of the Malay Peninsula and of the islands of Java and Borneo.

24755. GLYCOSMIS PENTAPHYLLA (Retz.) Correa.

Distribution.—Throughout tropical and subtropical Himalaya, ascending to 7,000 feet in Sikkim; also in southern China, in the Philippines, and in northeastern Australia.

24756. QUERCUS SUBER L. **Cork oak.**

From Seville, Spain. Presented by Mr. Peter Campbell, president of the Nairn Linoleum Company, Kearney, N. J. Received February 19, 1909.

Acorns for propagating young trees, to be used in acclimatization experiments. See S. P. I. No. 3039 for description.

Distribution.—A native of the shores of the Mediterranean Sea, in Spain, France, Corsica, Sardinia, Italy, Sicily, and northern Africa. Cultivated in India and in California.

24757 and 24758. MEDICAGO spp.

From Bavaria, Germany. Presented by Mr. John S. Haas, with S. B. Bing Sons, Nuremberg, Germany, who procured the seed from Mr. George Liebermann, Nuremberg, Germany, at the request of Mr. J. M. Westgate. Received February 15 and 18, 1909.

Seeds of the following:

24757. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

24758. MEDICAGO SATIVA L. **Alfalfa.**

Provence.

24759 to 24761. PHYLLOSTACHYS spp. **Bamboo.**

From Nagasaki, Japan. Purchased from Japanese bamboo growers by Mr. William D. Hills, agricultural explorer. Received at the Plant Introduction Garden, Chico, Cal., February 9, 1909.

"This importation of the three most valuable Japanese timber bamboos was made for the planting, on a larger scale than any hitherto yet attempted, of experimental bamboo groves in Florida, Louisiana, and California, in order that the feasibility of growing them on a commercial scale might be definitely determined." (*W. Fischer.*)

24759. PHYLLOSTACHYS MITIS (Lour.) Riviere. **Moso.**

"This is the great edible bamboo of China and Japan and the largest of the hardy species, the culms attaining a maximum height of 70 to 80 feet and a diameter of 6 to 8 inches. It may readily be distinguished from the *Madake*, the next largest species, by the comparatively shorter internodes, the gentle curving of the culm just after it leaves the ground, and by the broad-based pseudophyll, which tapers to a point with the fringe of hairs on the sheath near its base." (*W. Fischer.*) See No. 12178 for previous introduction.

24760. PHYLLOSTACHYS QUILIOI Riviere. **Madake.**

"The great timber bamboo of China and Japan and the second largest in size, the culms attaining a maximum height of 60 or 70 feet and a diameter of 6 inches. Besides the proportionately longer internodes and the habit of the culm in rising straight from the rhizome it is distinguished from the *Moso* by the wavy outline of the pseudophyll and by the more pronounced purple or reddish blotches on the sheath. This species is considered somewhat more hardy than *P. mitis;* the rhizome is more vigorously spreading, and the wood is harder. It is the most useful of the East Asiatic bamboos." (*W. Fischer.*) See No. 12180 for previous introduction.

24761. PHYLLOSTACHYS HENONIS Mitford. **Hachiku.**

"Next in importance and smaller than the two preceding species, with a height of from 30 to 40 feet and a diameter of from 3 to 4 inches. The sheath has fine lines, forming purple markings but no blotches. The stem nodes are flatter than those of the *Madake*, the culms are thinner walled, and the sprouts are produced earlier." (*W. Fischer.*) See No. 12177 for previous introduction.

24762. SCLEROCARYA CAFFRA Sond. **Morula.**

From Pretoria, Transvaal, South Africa. Presented by Prof. J. Burtt Davy, government agrostologist and botanist, Department of Agriculture. Received March 1, 1909.

Seed of a tree with compound, alternate, unequally pinnate leaves clustered at the ends of the branches. The flowers, borne in spicate racemes, are one-fourth inch in diameter, with recurved petals. The fruit is a two-seeded drupe, about the size of a small walnut, with an acid and resinous pulp. The thick, oily cotyledons are eaten in times of famine.

Distribution.—A native of Africa, found near Lake Nyassa and other localities in the Zambezi Valley, in the Macalisberg Mountains, and in Cape Colony.

24763. Indigofera subulata Vahl.

From Kingston, Jamaica. Presented by Mr. William Harris, superintendent of public gardens, Department of Agriculture, Hope Gardens. Received February 23, 1909.

Seeds.

Distribution.—Found in both the East and West Indies, in Mexico, and on the Florida keys; in Upper Guinea and Senegambia, in Africa; and on the plains of the western peninsula of India and in Ceylon.

24766. Stizolobium sp. **Florida velvet bean.**

From Biloxi, Miss. Grown by Prof. S. M. Tracy, special agent. Received February 25, 1909.

White. "A variety of the Florida velvet bean with white or nearly white seeds. Limited experience with it indicates that it is more prolific than the ordinary velvet bean. Grown from S. P. I. No. 22923." (*C. V. Piper.*)

24767. Medicago sativa L. **Alfalfa.**

From Tauberbischofsheim, Baden, Germany. Secured from Landwirtschaftliches Lagerhaus für das Frankenland, through Mr. Charles J. Brand. Received February 11, 1909.

"*Alt-Deutsche Fränkische* lucern. The chief area of production of this strain of alfalfa is the district known as the Taubergrund, in northern Baden and Württemberg and western Bavaria. The Taubergrund includes practically the whole drainage basin of the Tauber, a short stream that rises in the heights of Franconia and empties into the Main near Wertheim. The seed is also produced to some extent in the Neckarthal of Baden and Württemberg.

"Tauberbischofsheim, the source of the present sample, is only about six miles distant from Külsheim, the original home of Wendelin Grimm, who brought the now well-known *Grimm* alfalfa to Minnesota in 1857. At the request of the writer, Mr. Ludwig Keller, of Oberschüpf, Baden, made some inquiries into the history of *Old German Franconian* alfalfa. The following, in free translation, is quoted from his report: 'This lucern was probably introduced into this country (Germany) at a very early time; it has adapted itself to the existing local conditions and has developed into a special strain of a certain constancy. Doubtless it is the same alfalfa that Farmer Grimm took with him to America. No other form is cultivated in our section on account of the superiority of this one.' (P. L. H. No. 3385.)" (*Brand.*)

24768 and 24769. Garcinia spp.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Department of Agriculture. Received February 27, 1909.

Seeds of the following:

24768. Garcinia mangostana L.

Distribution.—A small native tree of southern Tenasserim and the Malay Peninsula, in India, and of the Malay Archipelago. Cultivated in Ceylon and in the Madras Presidency and in Trinidad and Jamaica in the West Indies.

24769. Garcinia cowa Roxb. (?)

For experiments in grafting the mangosteen.

Distribution.—A native tree of India, extending from the hills of eastern Bengal, through Assam and Burma, and to the Andaman Islands.

24770. CHAYOTA EDULIS Jacq. **Chayote.**

From Mayaguez, P. R. Presented by Mr. D. W. May, Agricultural Experiment Station. Received February 27, 1909.

A medium-sized, smooth, pale-green variety, almost white; practically spineless. Secured for the purpose of carrying on experiments in the South with a view to encouraging its culture for the market. For distribution of this species see No. 24671.

24771 to 24819.

A collection of seeds and cuttings. Received through Prof. N. E. Hansen, of the Agricultural Experiment Station, Brookings, S. Dak., while traveling as an agricultural explorer for the Department of Agriculture, December 3, 1908.

24771 to 24793. VITIS VINIFERA L. **Grape.**

"(Nos. 196 to 218.) A collection of native table and raisin grapes of central Asia grown by the Mohammedans from time immemorial. In recent years the manufacture of wine has assumed large proportions, since the conquest of the natives. The best variety is probably the *Maskah*, Nos. 197, 199, 209, and 218 (S. P. I. Nos. 24772, 24774, 24784, and 24793); it may prove to be the largest grape in cultivation. The last two or three years the *Maskah* has found its way to St. Petersburg markets, since the completion of the Orenburg-Tashkend Railway, where it caused a great sensation and sold for a much higher price than the largest grapes shipped from France, Germany, and the Crimea. All these vines should be tested as individuals till fruited, as the nomenclature is uncertain in these native vineyards." (*Hansen.*)

24794. POPULUS sp. **Poplar.**

"(No. 219.) Cuttings of a native poplar of upright habit like the Lombardy poplar. From Tashkend, Turkestan." (*Hansen.*)

24795. MALUS SYLVESTRIS Mill. **Apple.**

"(No. 220.) Scions of *Pyrus malus* (*Malus sylvestris*) *Namanganica*, a red-fleshed apple, native of eastern Turkestan, adjoining the Pamir plateau." (*Hansen.*)

24796. MALUS SYLVESTRIS Mill. **Apple.**

"(No. 221.) *Napoleon* apple, a new French variety of delicious flavor. Scions obtained at Tashkend, Turkestan." (*Hansen.*)

24797. PRUNUS ARMENIACA L. **Apricot.**

"(No. 219.) Scions of native apricot from Tashkend, Turkestan." (*Hansen.*)

24798. PUNICA GRANATUM L. **Pomegranate.**

"(No. 223.) Tree of choice native variety grown at Tiflis, Transcaucasia." (*Hansen.*)

24799. PUNICA GRANATUM L. **Pomegranate.**

"(No. 224.) Plant of a native variety grown at Tiflis, Transcaucasia." (*Hansen.*)

24800. ELAEAGNUS ANGUSTIFOLIA L. **Oleaster.**

"(No. 225.) A large-fruited variety from Tiflis, Transcaucasia." (*Hansen.*)

24801. RIBES sp. **Currant.**

"(No. 226.) Native currant from Tiflis, Transcaucasia." (*Hansen.*)

24802. MALUS SYLVESTRIS Mill. **Apple.**

"(No. 227.) Native apple *Schachalma*, from Tiflis, Transcaucasia." (*Hansen.*)

24803. ELAEAGNUS ANGUSTIFOLIA L. **Oleaster.**

"(No. 228.) A large-fruited variety from Tiflis, Transcaucasia." (*Hansen.*)

24771 to 24819—Continued.

24804. Morus nigra L. **Black mulberry.**

"(No. 229.) A choice-fruited native variety from Tiflis, Transcaucasia." (*Hansen.*)

Distribution.—A native of southern Russia in the vicinity of the Caucasus Mountains and the Caspian Sea; also cultivated in warm climates.

24805. Malus sylvestris Mill. **Apple.**

"(No. 230.) A native apple *Paschalma*, from Tiflis, Transcaucasia." (*Hansen.*)

24806. Amygdalus persica L. **Peach.**

"(No. 251.) Peculiar native, flat, small peach pits, from Tashkend, Turkestan." (*Hansen.*)

24807. Amygdalus persica L. **Peach.**

"(No. 252.) Native peach pits from Tashkend, Turkestan." (*Hansen.*)

24808. Amygdalus nana L. **Russian almond.**

"(No. 253.) Variety *Spinosissima.* Native dwarf almond from Alatau Mountains, 80 versts from Tashkend, Turkestan. See No. 257 (S. P. I. No. 24809)." (*Hansen.*)

24809. Amygdalus nana L. **Russian almond.**

"(No. 257.) Variety *Petronnikow.* Dwarf native almond from Chingan Mountains, 90 versts from Tashkend, Turkestan. See No. 253 (S. P. I. No. 24808)." (*Hansen.*)

24810. Chaetochloa italica (L.) Scribn. **Millet.**

"(No. 258.) Originally from Manchuria. Seed grown at experiment station in Golodnaya or Hunger steppe, Turkestan." (*Hansen.*)

24811. Medicago sativa L. **Alfalfa.**

"(No. 259.) The '*Turcestanica*' is a name given by the Russian agronomists to distinguish the alfalfa native of Turkestan from that obtained from other regions. The present sample is as grown in Golodnaya or Hunger steppe, Turkestan. Since I brought the first lot of Turkestan alfalfa to the United States in the spring of 1908 an enormous export of alfalfa seed has sprung up in Turkestan, especially from the Khanate of Khiva. It was stated to me in Turkestan in December, 1908, that fully 200,000 pood go from Khiva each year (a Russian pood is 32 pounds avoirdupois); also that perhaps 100,000 pood go from the rest of Turkestan. In Khiva the multitude of camels which eat the dry fodder left after the seed is removed makes it possible to raise the seed cheaper at Khiva. Most of the seed goes to South America, but a considerable and steadily increasing lot goes to North America. Some of the seed sold commercially does not come from Turkestan, but it is said comes from farther south. It is to be hoped that the alfalfa seed business will be better handled in the future and that each strain is correctly labeled." (*Hansen.*)

24812. Andropogon sorghum (L.) Brot. **Durra.**

"(No. 249.) '*Dshu-gah-rah,*' from Khokand region, Turkestan, raised in the Golodnaya or Hunger steppe, between Tashkend and Samarkand, Turkestan. Extensively used for stock feed and also for human food." (*Hansen.*)

"'*Dzhugara,*' similar to S. P. I. No. 24553. Base of some glumes black." (*Carleton R. Ball.*)

24771 to 24819—Continued.

24813. Phaseolus radiatus L. **Mung bean.**

"(No. 250.) Green gram as grown at Tashkend, near northern limit of cotton culture in Turkestan. Promising for culinary use and as a cover or catch crop in very dry, hot regions. It is largely grown in Turkestan under conditions similar to those obtained in New Mexico and Arizona." (*Hansen.*)

Both the green-seeded and black-seeded variety were in this lot.

24814. Medicago arborea L. **Tree alfalfa.**

"(No. 256.) Seed from Vilmorin-Andrieux & Co., Paris, France, purchased February 2, 1909, the day before I took the steamer for America. Seed as grown in southern France. There appears to be a limited call for the seed in southern France, southern Italy, and northern Africa as a plant for very dry, stony places." (*Hansen.*)

Distribution.—A native of southern Europe, being found in Italy and Greece.

24815. Avena sativa L. **Oat.**

"(No. 74.)"

24816. Eragrostis abyssinica (Jacq.) Schrad. **Teff.**

"(No. 231.) A white-seeded form of a grass from Abyssinia, deemed valuable for dry regions. This sample was grown at the experiment station in Golodnaya or Hunger steppe, Turkestan." (*Hansen.*) See S. P. I. No. 24887 for distribution of this species.

24817. Trifolium lupinaster L.

"(No. 68.) A native clover common on the open steppe over an immense area of Siberia, extending north to the Arctic Circle. For the severest sections only. This lot was gathered near Obb, western Siberia, where the Obi River crosses the Siberian railway. Leaflets 5, like a lupine, whence the name *lupinaster*." (*Hansen.*)

24818. Trifolium lupinaster L.

See S. P. I. No. 24458 for distribution of this species.

24819. Triticum aestivum L. **Wheat.**

"(No. 77?.) Sample from Iresnoye village near Obb, Tomsk Province, at intersection of Obi River and Siberian railway, western Siberia. A good productive variety in this region." (*Hansen.*)

24825. Punica granatum L. **Pomegranate.**

From La Tour-de-Peilz, Vaud, Switzerland. Purchased from Mr. J. Brunner, at the request of Mr. O. F. Sillig, of this Department. Received March 9, 1909.

Plants and cuttings.

Legrellei. "A type of pomegranate remarkable for its vigor and hardiness. Supposed to be the only variety with double flowers which will flower and sometimes ripen its fruits in a climate like that of central France and even near Paris, provided that it is planted in a favorable exposure. Petals salmon-red, lined with white, the tips sometimes spotted or striated with white." (*Sillig.*)

24828 to 24833. GOSSYPIUM BARBADENSE L. **Cotton.**

From Egypt. Presented by F. Fletcher, esq., School of Agriculture, Ghizeh, Egypt, at the request of Mr. T. H. Kearney. Received February 27, 1909.

24828.	*Ashmuni.*	**24831.**	*Sultani.*
24829.	*Mit Afifi.*	**24832.**	*Jannovitch.*
24830.	*Abbasi.*	**24833.**	*Nubari.*

These cottons were obtained for Mr. T. H. Kearney's experimental work in the Southwest.

24839 and 24840. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Grown at the Arlington Experimental Farm, Virginia, from seed obtained from Dr. S. P. Barchet, Shanghai, China, in 1906.

Seed of the following:

24839. Greenish. Grown in 1908 under temporary numbers 0578 and 0579, which proved to be identical.

24840. Yellow. Grown in 1908 under temporary number 0580.

24845 to 24851.

From China. Received through Mr. E. H. Wilson, of the Arnold Arboretum, Jamaica Plain, Mass., in cooperation with this Department, February 4, 1909.

The following seeds:

24845. TRITICUM AESTIVUM L. **Wheat.**

"(No. 1381.) The wheat commonly cultivated around Tatienlu, China, at altitudes between 8,000 and 11,000 feet." (*Wilson.*)

24846 and 24847. AVENA NUDA L. **Oat.**

"(Nos. 1382 and 1382a.) These are the oats cultivated in the neighborhood of Tatienlu, China, at from 6,500 to 11,000 feet altitude." (*Wilson.*)

24848. HORDEUM VULGARE HIMALAYENSE Rittig. **Barley.**

Distribution.—Cultivated in the mountains of the Chinese Empire, at elevations from 9,000 to 14,000 feet.

24849. HORDEUM VULGARE VIOLACEUM Koern. **Barley.**

"(Nos. 1379 and 1380.) These are barleys cultivated in the highlands west of Tatienlu, China. No. 1380 (S. P. I. No. 24849), a purple kind, is capable of cultivation at greater altitudes than any other cereal both in west and northwest Szechwan, China. Its belt is 11,000 to 13,000 feet." (*Wilson.*)

Distribution.—Cultivated in the mountains of the Chinese Empire. Also reported as cultivated in Sweden.

24850. FAGOPYRUM TATARICUM (L.) Gaertn. **Buckwheat.**

"(No. 1383.) *Ku ch'iao* is the buckwheat commonly cultivated to the west and southeast of Tatienlu, China." (*Wilson.*)

Distribution.—Cultivated in the mountains of China, and in India and to some extent in Europe.

24851. RHEUM sp. **Rhubarb.**

"(No. 1247.) This medicinal rhubarb is fairly common in the uplands to the west and southeast of Tatienlu, China, at altitudes between 10,000 and 12,000 feet. It prefers moist, rocky ground. I have sent it that you may compare it with the rhubarb sent from Hupeh, China, last year (S. P. I. No. 21319). Personally I consider the plants identical." (*Wilson.*)

24853 to 24855.

From Hangchow, Chekiang, China. Presented by Rev. W. S. Sweet. Received March 5, 1909.

The following seeds, notes by Mr. Sweet:

24853. Cannabis sativa L. **Hemp.**

"This is the Stewart hemp grown in Kentucky."

24854. Corchorus capsularis L. **Jute.**

24855. Sesamum orientale L. **Sesame.**

"Used here on cakes for food."

24856 to 24858.

From Florence, Italy. Presented by the Comizio Agrario di Firenze, Sezione Consorzio Agrario per l'Acquisito di Materie Utili in Agricoltura, through Mr. Charles J. Brand. Received February 27, 1909.

The following seeds:

24856 and 24857. Onobrychis viciaefolia Scop. (Onobrychis sativa Lam.) **Lupinella.**

24856. (P. L. H. No. 3389.)

24857. (P. L. H. No. 3390.)

"*Lupinella sgusciata.*"

Distribution.—An herbaceous perennial, native to Europe and extending into Asia. Occasionally used in the southern part of the United States as a forage crop.

24858. Medicago sativa L. **Alfalfa.**

"*Herba medica.*" (P. L. H. No. 3391.)

24859. Medicago sativa L. Alfalfa.

From Bridgeport, Kans. Purchased from Mr. Carl Wheeler. Received March 6, 1909.

"Variegated alfalfa, grown in 1908 without irrigation, at Bridgeport, Kans., from a field seeded in 1891 and which since has suffered no deterioration in stand. The field also produced good crops of seed in 1905, 1906, and 1907." (*J. M. Westgate.*)

24876. Alectryon excelsum Gaertn. Titoki.

From Wellington, New Zealand. Presented by Mr. T. E. Donne, secretary, Department of Industries and Commerce. Received March 8, 1909.

Seeds.

"The titoki is a handsome evergreen tree, from 40 to 60 feet high, with a trunk sometimes 3 feet in diameter, but usually smaller.

"The fruit is both singular and handsome; when ripe it is one-third inch long, and almost woody, with a flattened crest on the upper portion, terminating in a spur-like prominence on one side; when the seed is ripe the fruit vessel becomes ruptured transversely, but not along any definite line. It is one celled, and contains a single pear-shaped, black seed, which is surrounded by a bright-scarlet, fleshy cup, termed an 'aril,' and has a granulated surface; the fiery scarlet of the aril and the glossy jet-black seed form a pleasing contrast, which is harmonized by the deep-russet pubescence of the fruit vessel.

"The flowers are produced during the months of November and December; the fruit requires a year to arrive at maturity, so that flowers and ripe fruit may be found on the tree at the same time.

24876—Continued.

"*Properties and uses.* Although the titoki does not afford a durable timber under exposure, it is justly valued on account of its great strength, toughness, and elasticity, while it is straight in the grain, even, compact, and easily worked; it is of light reddish color and destitute of figure.

"It is suitable for purposes which demand great strength and elasticity, but do not involve any great amount of exposure to the weather. It is highly valued for bullock yokes; with the exception of mangiao it is perhaps the best of all New Zealand timbers for that purpose; it is excellent for ax handles and for the handles of carpenters' tools, for singletrees, for light framing for machinery, and for some purposes of the cabinetmaker; but is most highly esteemed by the wheelwright and coach builder, being used for light spokes, fellies, hubs, panels, and bent ware. It is also suitable for the manufacture of the woodwork of many kinds of agricultural implements.

"*Distribution.*—Alectryon comprises only a single species, which is endemic in New Zealand. It is common in lowland woods or on their margins throughout the North Island, and, crossing Cook Strait, finds its southern limit on Banks Peninsula, on the east coast, and between Hokitika and Ross, on the west coast.

"Although essentially a lowland plant, it ascends from the sea level to upward of 2,000 feet." (*"The Forest Flora of New Zealand," by Thomas W. Kirk, F. L. S.*)

"It may be of interest to know that this was introduced from New Zealand to California at least thirty-five years ago, and there are trees bearing regularly at Berkeley and elsewhere in northern California; but it is such a slow grower that nobody ever paid much attention to it." (*Extract from letter of Dr. F. Franceschi, April 14, 1909.*)

24878. ANDROPOGON SORGHUM (L.) Brot. **Milo.**

From Liberal, Kans. Purchased from Mr. John L. Boles. Received March 8, 1909.

"Grown from G. I. No. 235, selected originally for earliness, dwarfness, uniformity, and productiveness." (*Carleton R. Ball.*)

24879. PANICUM DIVARICATUM L. (?)

From Surinam, Dutch Guiana. Presented by Mr. J. R. Wigman, director, Botanic Garden, Paramaribo, Surinam. Received March 9, 1909.

24880 to 24911.

From Abyssinia. Presented by Mr. Hubert S. Smiley, Drumalis, Larne, Antrim County, Ireland. Received March 2, 1909.

The following seeds:

24880. HORDEUM DISTICHON L. **Barley.**

Two rowed, white. "Grown in January on any ground; irrigation necessary."

24881. HORDEUM sp. **Barley.**

Two rowed, white. "Grown in June on any ground except black earth."

24882. HORDEUM sp. **Barley.**

Two rowed, black. "Grown in June on high land."

24883. TRITICUM sp. **Wheat.**

Black. "Grown in June and August on high and low land."

24884. TRITICUM AESTIVUM L. **Wheat.**

White. "Grown in July on the plateau."

24880 to 24911—Continued.

24885. TRITICUM AESTIVUM L. **Wheat.**

Purple. "Grown in July on any ground."

24886. TRITICUM sp. **Wheat.**

"Grown in August on clay ground."

24887 and 24888. ERAGROSTIS ABYSSINICA (Jacq.) Schrad. **Teff.**

24887. Brown. **24888.** White.

Distribution.—A native of the northeastern part of Africa, being cultivated in the mountains of Abyssinia and also in India.

24889 and 24890. CICER ARIETINUM L. **Chick-pea.**

24889. Brown. **24890.** Black.

24891 and 24892. LINUM USITATISSIMUM L. **Flax.**

24891. Brown. **24892.** White.

24893 to 24895. PISUM ARVENSE L. **Field pea.**

24893. Brown. **24895.** White.

24894. Black.

24896. ZEA MAYS L. **Corn.**

"Grown on low ground."

24897. ANDROPOGON SORGHUM (L.) Brot. **Durra.**

"Grown in March on low ground."

"A durra with small red seeds, much resembling red kafir seeds; apparently identical with No. 12373." (*Carleton R. Ball.*)

24898. TRIGONELLA FOENUM-GRAECUM L. **Fenugreek.**

"Grown in July on any ground."

24899. ANDROPOGON SORGHUM (L.) Brot. **Durra.**

"Brown-seeded variety; seems to be identical with No. 11067." (*Carleton R. Ball.*)

24900. VICIA FABA L. **Horse bean.**

"Grown in June on heavy brown ground."

24901. HORDEUM VULGARE COELESTE L. **Barley.**

Six-rowed hull-less white and black seeded variety.

24902. GUIZOTIA ABYSSINICA (L. f.) H. Cass.

"A black pulse for making oil. Grown in July on clay ground."

Distribution.—A native and cultivated herbaceous plant of tropical Africa; also cultivated in India.

24903. TRITICUM MONOCOCCUM L. **Emmer.**

"Grown in June on any ground."

24904. LENS ESCULENTA Moench. **Lentil.**

24905. CORIANDRUM SATIVUM L. **Coriander.**

24906. PHASEOLUS VULGARIS L. **Bean.**

White.

24907. PIMPINELLA ANISUM L. **Anise.**

24908. CARTHAMUS TINCTORIUS L. **Safflower.**

"For making oil. Grown in July."

24880 to 24911—Continued.

24909. Nigella sativa L.

Distribution.—A native of the southern part of Europe and cultivated in the Mediterranean region and in India.

24910. Andropogon sorghum (L.) Brot. **Durra.**

"White. Probably identical with some of the Abyssinian sorghums imported and grown in 1904." (*Carleton R. Ball.*)

24911. Hordeum sp. **Barley.**

Two-rowed black variety. "Grown in January in very cold country."

24912 to 24914. Dolichos lablab L. **Bonavist bean.**

From Herradura, Cuba. Presented by Mr. F. S. Earle. Received March 8, 1909.

Seeds of the following:

24912. White.

24913. Brown.

24914. Black.

24915 and 24916. Amygdalus persica L. **Peach.**

From about six miles out from Canton, China. Procured by Mr. G. W. Groff. Received at the Plant Introduction Garden, Chico, Cal., February, 1909.

Grafts of the following:

24915. *Hung wat to* (red-stone peach).

24916. *Paak wat to* (white-stone peach).

"The *Hung wat to* is a new variety and so recognized by the Chinese. From what I can gather they believe the *Paak wat to* to be the best, but have some trees of the *Hung wat to.* The *Hung wat to* seems to blossom much quicker than the *Paak wat to.*" (*Groff.*)

24917. Corchorus capsularis L.

From Shanghai, China. Presented by Rev. J. M. W. Farnham. Received March 9, 1909.

24921. Rosa sp. **Rose.**

From Battle Mountain, Nev. Presented by Mrs. W. C. Hancock. Received March 12, 1909.

"A small double rose, very floriferous, resembling the Chinese yellow rose; plant medium tall, bushy, very hardy." (*Frank N. Meyer.*)

24922. Stizolobium sp.

From Saigon, Cochin China. Presented by the Botanical Garden of Saigon, through Mr. Jacob E. Conner, United States consul. Received March 20, 1909.

24923. Medicago sativa L. **Alfalfa.**

From Heilbronn, Württemberg, Germany. Purchased from Mr. Heinrich Becker, at the request of Mr. Charles J. Brand. Received March 12, 1909.

Alt-Deutsche Fränkische lucern.

24924. Hibiscus sp.

From Oporto, Portugal. Presented by Baron de Soutellinho, 115 Entre Quintas. Received March 11, 1909.

"A pretty pink Hibiscus. It was a hybrid raised by me of *Hibiscus coccineus* Walt. × *moscheutos* L. The culture is the same as for *H. coccineus* Walt. It is a deciduous perennial." (*Soutellinho.*)

24925. POLYGONUM BISTORTA L.

From Berlin, Germany. Presented by Prof. Dr. A. Engler, Director of the Royal Botanic Garden. Received March 12, 1909.

"The root of this species of Polygonum is reported to contain from 13.5 to 21 per cent of tannin. Introduced to test its availability as an agricultural crop for tannin production." (*W. W. Stockberger.*)

Distribution.—Found throughout the temperate region of Europe and Asia, extending into alpine and arctic regions.

24926. TRIFOLIUM PRATENSE L. **Red clover.**

From Knoxville, Tenn. Received through Mr. S. M. Bain, special agent, March 3, 1909.

"This seed is from plants which successfully resisted the attacks of *Colletotrichum trifolii* Bain. This disease has materially affected the successful production of clover in Tennessee and elsewhere." (*J. M. Westgate.*)

24927. MANGIFERA INDICA L. **Mango.**

From Cavite, Luzon, P. I. Presented by Mr. Donald MacIntyre, Moanalua Gardens, Honolulu, Hawaii Territory. Received March 3, 1909.

Caraboa. The same remarks apply to this as to No. 24170.

Distribution.—A large tree, native to the tropical region of India and cultivated generally in the Tropics. In America cultivated in the West Indies, in tropical Mexico, and in southern Florida and southern California.

24928 to 24933.

From Riedöschingen, Germany. Purchased from Mr. Conrad Boehler, Alma, Nebr., through Mr. J. M. Westgate. Received February 26, 1909.

The following seeds (notes by Mr. Boehler):

24928. MEDICAGO SATIVA L. **Alfalfa.**

Provence. This is one of the best and most productive fodder plants of Germany, lasting eight to ten years.

24929. TRIFOLIUM PRATENSE L. **Red clover.**

The standard legume hay crop of Germany.

24930. TRIFOLIUM REPENS L. **White clover.**

This clover, harvested while in bloom, produces the well-known calf hay.

24931. ONOBRYCHIS VICIAEFOLIA Scop. **Sainfoin.**

Esparsette, or sainfoin, produces good, sweet hay. Lasts from six to eight years.

24932. VICIA SATIVA L. **Common vetch.**

Especially suitable for green manuring on poor soils. May be seeded alone or with oats for green fodder.

24933. MEDICAGO LUPULINA L.

An excellent weed destroyer; produces a high yield, but a rather rough fodder. It can be cut but once.

24935 and 24936. STIZOLOBIUM spp.

From Ceylon. Presented by Mr. C. Drieberg, secretary, Ceylon Agricultural Society, Colombo, Ceylon. Received March 13, 1909.

Seeds of each of the following:

24935. Small, black.

24936. Gray.

24938. CHAYOTA EDULIS Jacq. **Chayote.**

From Los Angeles, Cal. Presented by Mr. M. E. Cheney. Received March 15, 1909.

A medium-sized, pear-shaped, white variety, secured for cooperative work with the State Experiment Station, Baton Rouge, La. See No. 24671 for distribution of this species.

24939. PHASEOLUS SEMIERECTUS L.

From Belize, British Honduras. Presented by Mr. E. J. F. Campbell, superintendent, Botanic Station. Received February 24, 1909.

See No. 24639 for distribution of this species.

24940. PISUM ARVENSE L. **Field pea.**

From Guelph, Ontario, Canada. Presented by Prof. C. A. Zavitz, Ontario Agricultural College. Received March 16, 1909.

Early Brittain. An extremely promising variety, recently introduced into Ontario.

24956 to 24997. ANDROPOGON SORGHUM (L.) Brot.

Grown on the government experimental farm at Amarillo, Tex., by Mr. John F. Ross, season of 1908. Received March, 1909.

The following seeds:

24956 to 24964. **Milo.**

24956. (G. I. No. 223.)
24957. (G. I. No. 224.)
24958. (G. I. No. 227.)
24959. (G. I. No. 229.)
24960. (G. I. No. 230.)
24961. (G. I. No. 231.)
24962. (G. I. No. 232.)
24963. (G. I. No. 234.)
24964. (G. I. No. 331.)

Selected since 1905 for dwarf stature, erect heads, productiveness, and other desirable characteristics by Messrs. A. H. Leidigh and Carleton R. Ball.

24965 to 24970. **Dwarf milo.**

24965. (G. I. No. 149A.)
24966. (G. I. No. 149B.)
24967. (G. I. No. 149C.)
24968. (G. I. No. 236.)
24969. (G. I. No. 332A.)
24970. (G. I. No. 332B.)

Selected since 1905 for dwarf stature, erect heads, productiveness, and other desirable characteristics by Messrs. A. H. Leidigh and Carleton R. Ball.

24971 to 24984. **Blackhull kafir.**

24971. (G. I. No. 71.)
24972. (G. I. No. 204.)
24973. (G. I. No. 205.)
24974. (G. I. No. 206.)
24975. (G. I. No. 207.)
24976. (G. I. No. 210.)
24977. (G. I. No. 333.)
24978. (G. I. No. 335.)
24979. (G. I. No. 336.)
24980. (G. I. No. 337.)
24981. (G. I. No. 338.)
24982. (G. I. No. 339.)
24983. (G. I. No. 340.)
24984. (G. I. No. 341.)

Selected since 1905 for dwarf stature, productiveness, and other desirable characteristics by Messrs A. H. Leidigh and Carleton R. Ball.

24956 to 24997—Continued.

24985 to 24989. Red kafir.

24985. (G. I. No. 34.) **24988.** (G. I. No. 212.)

24986. (G. I. No. 68.) **24989.** (G. I. No. 215.)

24987. (G. I. No. 69.)

Selected since 1905 for dwarf stature, productiveness, and other desirable characteristics by Messrs. A. H. Leidigh and Carleton R. Ball.

24990 to 24995. Brown kowliang.

24990. (G. I. No. 122.) Improved by selection for dwarf stature, productiveness, etc., from S. P. I. No. 17922 by Mr. Carleton R. Ball.

24991. (G. I. No. 123.) Improved by selection for dwarf stature, productiveness, etc., from S. P. I. No. 17923 by Mr. Carleton R. Ball.

24992. (G. I. No. 171A.) **24994.** (G. I. No. 171C.)

24993. (G. I. No. 171B.)

Improved by selection for dwarf stature, productiveness, etc., from S. P. I. No. 18518 by Mr. Carleton R. Ball.

24995. (G. I. No. 261.) Improved by selection for dwarf stature, productiveness, etc., from S. P. I. No. 20610 by Mr. Carleton R. Ball.

24996 and 24997. White durra.

24996. (G. I. No. 27.) Originally from Algeria, through France. Improved by Mr. Carleton R. Ball through selection for erect heads, seed-holding power, etc.

24997. (G. I. No. 81.) Seed supposedly from Egypt; received from Austria. Improved by Mr. Carleton R. Ball through selection for erect heads, seed-holding power, etc.

24998 and 24999.

From Para, Brazil. Presented by Mr. George H. Pickerell, United States consul. Received February 23, 1909.

The following seeds:

24998. VIROLA SURINAMENSIS (Rol.) Warb.

Distribution.—A native of the Amazon Valley in Brazil, of Guiana, and of the West India Islands.

24999. SAPINDUS SAPONARIA L.

Distribution.—A small tree found on the Florida keys, in Jamaica, and in Brazil. Cultivated in southern Florida and southern California.

25000. CAJAN INDICUM Spreng.

From Mexico. Presented by Mr. Elmer Stearns, botanist, School of Agriculture, C. Juarez, Chihuahua, Mexico. Received March 17, 1909.

"This plant grows to about 20 feet high here in Mexico in the warmer regions; it might do all right in southern California or the warmer belts farther north." (*Stearns*

25001 to 25015.

From near Bakuba, a distance of 9 hours from Bagdad, Turkey. Procured by Mr. William C. Magelssen, United States consul, Bagdad, Turkey, for Mr. T. H. Kearney's work in the Southwest. Received March 15, 1909.

The following cuttings:

25001 to 25007. Punica granatum L. **Pomegranate.**

25001. *Selimi.* "A vigorous and very beautiful tree; fruit very large (the largest pomegranate of all), weighing sometimes as much as 1 kilo; the skin is thin, sometimes bright red when ripe; crown small and short; pulp is melting, very thick, and of a very dark red. The seeds are thin and small. The taste is agreeable, slightly acid; the flavor is exquisite. The fruit is exquisite and of the very first quality; ripens in October. It is highly esteemed in the trade and will keep for a year." (*Kearney.*)

25002. *Hachiri* (indifferent). "Poor variety, blossoming much, but knotting little. Fruit average sized; skin thin, light green, tinged with pink. Pulp white, very sour, containing large seeds. The fruits, which are sold by the weight, are used as a condiment in the kitchen." (*Kearney.*)

25003. *Hilou Ahmar.*

25004. *Bila Hab* (seedless). "Obtained it is said by means of cuttings, the marrow of which is removed with a needle. The shrub is rather stubby, and bears little fruit. Fruit of average size, with light-green skin, almost white; pulp rosy colored, sweet, but flavorless and not luscious. In this pulp instead of seeds there is a white albumen, soft, watery, and without kernel, so that the fruit may be eaten entirely. This variety is rare and little sought after." (*Kearney.*)

25005. *Hilou Abiade* (sweet white). "Common tree, very fruitful; fruit rather large, thin skinned and of a light-green color; seeds elongated, white and with a tinge of pink. Pulp is luscious and sweet. This variety is common, but rather good." (*Kearney.*)

25006. *Roman Eswed* (black pomegranate). "Shrub with a reddish stem, longer boughs, and larger leaves than other varieties. Fruit of average size, round with flattened crown; bark rather thin, of a very dark-violet color. Pulp melting and of an agreeable, sourish-sweet taste. Excellent variety." (*Kearney.*)

25007. *Gourtmi.* "Very prolific tree; fruits small and growing in clusters at the end of the branches; the skin is thick, bright red and shiny. The seeds are rather large, with a sweet pulp. Indifferent variety." (*Kearney.*)

25008 to 25015. Vitis vinifera L. **Grape.**

25008. *Erz Roumli.*
25009. *Kurdi.*
25010. *Buhirzi.*
25011. *Kishmishi.*
25012. *Ajmi.*
25013. *Chaweesh.*
25014. *Chadeh Arabieh.*
25015. *Deis-al-A'anze.*

"The *Deis-al-A'anze* (S. P. I. No. 25015) is said to be a very good variety, the *Buhirzi* (S. P. I. No. 25010) is early ripening, and the *Erz Roumli* (S. P. I. No. 25008) very rich yielding." (*Magelssen.*)

25016 to 25021.

From Khartum, Sudan. Presented by Mr. R. Hewison, Director of Agriculture and Lands, Sudan Government, at the request of Mr. C. V. Piper. Received March 16, 1909.

The following seeds (native names quoted):

25016. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

"*Masri.*"

25017. ANDROPOGON HALEPENSIS (L.) Brot. **Johnson grass.**

"*Garawi.*"

"A variety of Johnson grass without rootstocks. This is a thing I have been looking for for some time, and judging from its behavior at Chillicothe, Tex., I think we have something that is going to be of high value. It looks something like Johnson grass, but is entirely devoid of rootstocks, and therefore could be easily eradicated." (*C. V. Piper.*)

Distribution.—Apparently a native of southern Europe and Asia, but distributed as a weed and by cultivation generally throughout warm countries, extending north in the United States to southern Pennsylvania and Missouri.

25018. DOLICHOS LABLAB L. **Bonavist bean.**

"*Kashrangague.*"

25019. MEDICAGO SATIVA L. **Alfalfa.**

25020. PENNISETUM AMERICANUM (L.) Schum. **Pearl millet.**

"*Dokhu.*"

Distribution.—Cultivated generally throughout the Tropics; used in the Southern States for the seed and grown farther north for fodder.

25021. CAJAN INDICUM Spreng.

"*Ads.*"

Distribution.—Probably a native of India, ascending to 6,000 feet in the Himalayas, and cultivated generally in the Tropics.

25022. MEDICAGO SATIVA L. **Alfalfa.**

From Oberschüpf, Baden, Germany. Secured from Mr. Ludwig Keller, Oberschüpf, amt Boxberg, Baden, Germany, at the request of Mr. Charles J. Brand. Received March 11, 1909.

Alt-Deutsche Fränkische lucern.

25068. PELARGONIUM ODORATISSIMUM (L.) Ait. **Geranium.**

From Algeria. Presented by Dr. L. Trabut, Government Botanist, Mustapha-Alger, Algeria. Received March 19, 1909.

"Cuttings of oil geranium cultivated in Algeria. This variety does not seed." (*Trabut.*)

This was procured for Dr. H. True's experiments in the production of rose geranium oil.

Distribution.—A native of the Cape of Good Hope; cultivated in Spain and Algeria.

25079. MEDICAGO SATIVA L. **Alfalfa.**

From Grand Isle, Vt. Collected by Mr. N. Schmitz, summer of 1908.

"Seed from a single plant of alfalfa. This individual plant was growing under very undrained-soil conditions and local testimony indicated that this and associated scattering plants had withstood the unfavorable conditions present for eighteen years." (*J. M. Westgate.*)

25080. Aleurites cordata (Thunb.) Muell. Arg.

Japan wood oil.

From Tokyo, Japan. Purchased from The Japan Seed and Plant Company (Limited). Received at Seattle, Wash., February 8, 1909. Received at Washington, D. C., March 23, 1909.

"This shipment of seeds was imported for acclimatization experiments and for the extraction of oil to be used in chemical and physical analyses for comparison with S. P. I. No. 25081.

"In Japan this species is most commonly known under the names *abura-giri* and *yama-giri*, meaning, respectively, oil-kiri and wild-kiri, kiri (giri) being the name for *Paulownia imperialis*, which it greatly resembles in its foliage. It is a tropical or semitropical plant and grown only in the provinces to the south of Tokyo (36° lat.). It is found also in Formosa, the coastal provinces of China as far inland as Chekiang, the Isle of Hainan, and sparingly in farther India and Cochin China, being indigenous probably to Japan and Formosa only.

"The seeds are very small compared with those of the other species of Aleurites, being about the size of large castor-oil seeds, which they very much resemble. The oil expressed from them, which serves chiefly as a drying oil, is comparable to the more abundant t'ung oil of China and to perilla oil, which is largely substituted for it in Japan, as it can be more cheaply grown. In Japan, as in China, the wood oil is grown on land not suited for general farming." (*W. Fischer.*)

25081. Aleurites fordii Hemsl. **China wood oil.**

From Hankow, China. Purchased through Hon. William Martin, consul-general.

"This shipment of seeds was imported for the purpose of continuing on a large scale some experiments commenced four years ago in the acclimatization of the tree which produces the t'ung oil or China wood oil of commerce. Of the few 1-year-old seedlings distributed by mail throughout the Southern and Pacific States, those sent to the Gulf have done so unusually well, growing so rapidly and some of them blossoming and fruiting the second year from transplanting, that it was thought advisable, now that the section climatically best adapted to them has been discovered, to try larger plantations, not only to find out whether they would be a paying crop on cheap land in the South, but to determine the best treatment necessary to make them a commercial success.

"The *t'ung* tree or *t'ung-shu*, from the seeds of which China wood oil is obtained, is distributed widely throughout the provinces drained by the Yangtze, principally up the river and south of it, extending into the peninsula. Its product should not be confused with the true wood oil, or Gurjun balsam, which is an oleo-resin and which is the exudation from the trunks of several species of Dipterocarpus of Indo-China. The name "wood oil" for the Chinese product is really a misnomer and was applied by foreigners on account of the universal use of the oil as a covering for woodwork. To the Chinese the tree, seed, and oil are known, respectively, as *t'ung-shu*, *t'ung-tze*, and *t'ung-yü*, the word t'ung being applied also quite generally to several other trees of similar aspect of foliage, such as the catalpa, *Sterculia plantanifolia*, and *Paulownia imperialis*. The trees are more restricted to the thin, dry soils of the hilly regions, where farming is unprofitable and where also the Chinese claim that they bear larger crops. They are propagated by seeds which sprout in a short time and are placed where the trees are to stand permanently; also by hard-wood cuttings, which root readily. The tree should be tried in this country, not only for its valuable seeds, but as an ornament. It attains a height of from 20 to 40 feet, and its large, heart-shaped leaves, smooth, green bark, and striking panicles of white flowers slightly tinged with red, which appear with the leaves in the spring, make it a very desirable

25081—Continued.

ornamental tree at all seasons of the year. The fruits, which ripen in September, are the size of large, unhulled black walnuts and contain 5 warty seeds the size of chestnuts and the general form of castor-oil seeds.

"The seeds, which make up somewhat more than half by weight of the entire dried fruit, consist of 48 per cent shell and 52 per cent kernel, or 24 per cent oil cake and 28 per cent oil. During the past year the price of the oil in the United States was about 65 cents a gallon of 8 pounds, with linseed at 42 cents.

"For centuries the Chinese have found innumerable uses for wood oil, chief of which may be mentioned the preservation of woodwork from moisture, the waterproofing of cloth, umbrellas, etc., and the making of oil papers and putty; from the oil cake, various calking compounds and fertilizer, and the best India inks from the soot obtained from its combustion. Americans are the only foreigners who have used wood oil to any great extent and then only during the last ten or twelve years. Their appreciation of its good qualities is shown by the steady demand, which has led several importing firms to establish branch houses in the chief exporting centers, Hankow and Hongkong, and by the steadily increasing importations, which grew to 2,000,000 gallons in 1907.

"The wood oil now imported is used almost exclusively in varnish making, but the manufacture of such products as linoleum, enamel paints, and high-grade elastic oilcloths has just commenced, while other uses have been suggested. It belongs to the class of drying oils typified by linseed, but it is much harder, quicker drying, and more impermeable to water, though less lightproof and elastic. Owing to certain physical disadvantages which it possesses, it can not replace linseed, but used in conjunction with it gives most excellent results, especially for outdoor use, where such qualities as it possesses are highly desirable." (*W. Fischer.*)

Distribution.—A native of the southeastern part of China, extending from Hongkong north to the province of Hupeh.

25082 and 25083.

From China. Presented by Mr. D. MacGregor, Shanghai, through Mr. Frank N. Meyer. Received March 20, 1909.

Seeds of each of the following:

25082. ASTRAGALUS SINICUS L.

From near Shanghai. "Used in the Chekiang Province as a leguminous green-manure crop on the low-lying rice fields." (*Meyer.*)

Distribution.—A native of the southeastern part of the Chinese Empire, and of Japan.

25083. ARISAEMA sp. (?)

From Mokanshan. "Fruit plum colored, aromatic, vinuous flavor; seeds in pulp; fruit the size of a plum." (*MacGregor.*)

25087. PRUNUS PSEUDO-CERASUS Lindl. **Flowering cherry.**

From Japan. Purchased from the Yokohama Nursery Company. Received March, 1909.

"Seedling plants and seeds of the wild cherry of Japan upon which the Japanese bench-graft all their flowering cherries. I am informed by the Yokohama Nursery Company that this wild cherry, in contrast with the double-flowering and other Japanese ornamental varieties, can be reproduced very easily from cuttings, and that the scions of named varieties are grafted on pieces of the root and not budded, as is the custom in this country with the fruiting cherries. May this new stock not possibly

25087—Continued.

be easier to cultivate than the Mazzard or Mahaleb seedlings which are now in use and the propagating work done in the winter on the bench instead of in the field? The difficulties in getting a stock large enough to bud in regions where the leaf-blight is bad has suggested the trial of this Japanese wild cherry as a possible way out of this difficulty. By recent tests I have shown that this wild form strikes very easily in sand." (*Fairchild.*)

25088. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From Muskegon, Mich. Presented by Mr. C. D. McLouth. Received March 15, 1909.

Red Ripper (?). "My seed of this variety has been developed from a solitary plant found in a field of *Whippoorwill* cowpeas grown in 1905. This seed was purchased from a local dealer. It is by far the best variety I have grown in its earliness and abundant pod production." (*McLouth.*)

25089. BELOU GLUTINOSA (Blanco) Skeels.

From Philippine Islands. Presented by Mr. William S. Lyon, Manila, P. I. Received March 22, 1909.

Seed. See No. 24591 for description.

Distribution.—A small tree, native of the Philippine Islands.

25090 and 25091.

From Strasburg, Germany. Presented by Mr. George Wintz, Benson, Minn., through Mr. J. M. Westgate. Received March 15, 1909.

Seeds of each of the following:

25090. TRIFOLIUM PRATENSE L. **Red clover.**

25091. MEDICAGO SATIVA L. **Alfalfa.**

"This seed was received under the name *Spitzeklee*, which is said to be hardier than ordinary alfalfa." (*Westgate.*)

25094. FICUS SYCOMORUS L.

From Cairo, Egypt. Presented by Mr. W. Lawrence Balls, botanist, Khedivial Agricultural Society. Received March 22, 1909.

"This species of fig is grown largely along the north coast of Africa as a shade tree. Giant specimens are to be found in Alexandria and Cairo and at Biskra. The trees are beautiful shade trees, and make wonderful avenues in these dry climates where irrigation is practiced. The fruits are small, about the size of a pigeon's egg, and are sometimes eaten by the Algerian Arabs. They are, however, of no commercial importance.

"As the plants are grown easily from cuttings and make very rapid growth this tree may be expected to thrive well in the practically frostless regions of California and Florida. I do not know how low temperatures it will stand, but probably not more than a temperature of 18° or 20° F.

"Like many valuable things, it has its drawbacks. The Europeans in Egypt complain of a bad odor exhaled by the tree during the fruiting season." (*Fairchild.*)

"This tree will probably not fruit in the absence of its peculiar fig insect, which is in this case not a Blastophaga at all but belongs to another genus. Probably this will solve the malodorus fruit problem. I fear you will find it rather tender." (*Walter T. Swingle.*)

Distribution.—A large tree found in Egypt and the adjacent countries of the northeastern part of Africa.

25095. CITRULLUS VULGARIS Schrad. **Watermelon.**

From the island of Raiatea, Society Islands. Presented by Mr. Julius D. Dreher, United States consul, Tahiti, Society Islands. Received March 15, 1909.

"This melon was of a rich green color; its rind was thin and its pulp unusually red, tender, and sweet. It was eaten at the consulate and we regarded it as so good that I decided to send the seed to America for trial." (*Dreher.*)

25096. PASSIFLORA QUADRANGULARIS L.

From Ancon, Canal Zone, Panama. Presented by Mr. Henry F. Schultz, horticulturist, Isthmian Canal Commission, Quartermaster's Department. Received March 24, 1909.

"I doubt whether the fruit of this variety is as good as some of those in Mexico, but I must say that the seed was taken from one of the best fruits which I have sampled in Panama." (*Schultz.*)

Distribution.—A native of Central America, being cultivated as well as found wild in Guatemala, Nicaragua, and Panama.

25097 to 25101.

Grown at Miami, Fla., by Mr. P. J. Wester, in charge of Subtropical Garden. Numbered for convenience in recording distribution, March 24, 1909.

25097 and 25098. Original seed presented by Dr. A. Robertson Proschowsky, Nice, France.

25097. SOLANUM MARGINATUM L.

"(S. G. No. 1051.) A shrub attaining a height of from 3 to 5 feet; foliage white tomentose, prickly; flowers 1 inch or more in diameter, white with blue veins or ribs; fruit 1 inch or more across, prickly." (*Wester.*)

Distribution.—A native of the upper part of the Nile Valley, especially in Abyssinia.

25098. MELIA AZEDARACH L.

"(S. G. No. 1052.) Indigenous to Jamaica. A low-growing tree with leaves deeply incised; flowers in axillary panicles; small, light lilac, fragrant; in constant succession." (*Wester.*)

25099. CERATONIA SILIQUA L. **Carob.**

"(S. G. No. 900.) Original seed presented by Mr. J. F. Kraemer, Miami, Fla., who received it from a United States consul in Spain. This is said to be very superior to the ordinary varieties grown." (*Wester.*)

Distribution.—A tall tree, native in the region bordering on the Mediterranean Sea and cultivated generally in the Tropics. In the United States cultivated in southern Florida and southern California.

25100. GALPHIMIA NITIDA Hort.

"(S. G. No. 941.) Original seed presented by Mr. S. K. Brown, Lemon City, Fla. A shrub 4 or more feet tall, quite compact in growth and pyramidal in habit. The small, yellow, fragrant flowers are produced in great profusion." (*Wester.*)

25101. OCOTEA CATESBYANA (Mich.) Sarg. **Lancewood.**

"(S. G. No. 996.) Indigenous to south Florida and grown from seed collected in Brickell hammock, Miami, Fla. This is an evergreen, glabrous tree, attaining a height of from 20 to 30 feet; the leaves are narrowly elliptic lanceolate,

25097 to 25101—Continued.

making a very dense crown. From the observations I have made of this tree in its native habitat I believe it is well worth introducing as a shade tree in all parts of the United States where it would not be injured by frost." (*Wester.*)

Distribution.—A native of southern Florida and the Bahamas.

25104 to 25106. CHAETOCHLOA ITALICA (L.) Scribn. **Millet.**

From Haka, Chin Hills, Burma. Presented by Rev. H. East, A. B. Mission. Received March 10, 1909.

Seeds of the following:

25104. A yellow-seeded variety.

"Chin name *Fatao.* Is considered as good as rice by the Chins, and it is a good food, rich in gluten." (*East.*)

25105. A black-seeded variety.

"Chin name *Yet(r)ing.* Is also used as food, but is less valued than *Fatao* (S. P. I. No. 25104) and *Hlisen* (S. P. I. No. 25106)." (*East.*)

25106. A yellow-seeded variety.

"Chin name *Hlisen.* Has a large grain; is a good food, but not as rich as *Fatao* (S. P. I. No. 25104). Both kinds have unusually large heads." (*East.*)

"These three varieties need lots of water to grow." (*East.*)

25107. CAMOENSIA MAXIMA Welw.

From Angola, West Africa. Presented by Mr. John Gossweiler, botanist in the service of the Portuguese Government of Angola, at the request of Mr. A. E. Evans, Director of Agriculture, Gold Coast, West Africa. Received March 24, 1909.

Seeds.

"Probably the largest flowered and certainly one of the most delicately beautiful vines in the world is *Camoensia maxima*, which has recently flowered for the first time in the United States. Its pure white, fluted petals are margined with gold, changing to a darker tinge with age, and have a delicious fragrance when first opening. The individual flowers are sometimes 8 inches long, which we believe eclipses even the largest flowered hybrid clematis. This magnificent vine adorns the tops of lofty trees on the outskirts of forests in tropical Africa. The clusters are pendulous and sometimes contain nearly a dozen flowers. Unlike the sweet pea, the petals are separate, not forming wings and a keel. The standard is fully 4 inches across.

"The great drawback to the cultivation of this noble plant is that it will bloom only in hothouses of considerable size, and hitherto it has been extremely slow in coming into bloom. Plants were first distributed by Kew in 1873, but did not flower in cultivation until 1882, when blooms appeared at Trinidad. However, Mr. George W. Oliver, propagator to the United States Department of Agriculture, who first bloomed the Camoensia here, thinks it 'very likely that this plant will flower oftener and more profusely in this country than in Europe, particularly in England, because of our higher summer temperature, which enables the plant to grow rapidly and ripen its wood.'

"The Camoensia is named after the Shakespeare of the Portuguese, the poet Camoens, author of 'Lusiade.'" (*The Garden Magazine, May, 1908.*)

"I am informed by Doctor André, of Trinidad, that Camoensia is a wonderful success there. It ought to be extensively planted in Hawaii, Panama, Porto Rico, and the Philippines." (*Fairchild.*)

Distribution.—A tall-climbing vine, native of the woods of western tropical Africa, extending from Guinea through the Kongo region and into Portuguese West Africa.

25110 to 25112. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

From Zürich, Switzerland. Presented by Dr. G. Stebler, director, Schweizerische Samenuntersuchungs und Versuchsanstalt, Zürich, through Mr. Charles J. Brand. Received March 13, 1909.

Seeds of each of the following:

25110. (P. L. H. No. 3412.) **25112.** (P. L. H. No. 3414.)

25111. (P. L. H. No. 3413.)

"The samples of seed represented by these numbers were not grown in Switzerland, but were submitted by seedsmen to the seed control station for test." (*Brand.*)

25114. MEDICAGO SATIVA L. **Alfalfa.**

From the Arlington Experimental Farm, Virginia. Received March 27, 1909.

Peruvian. "Seed secured from crop of 1908 from transplanted crowns of Peruvian alfalfa. The original crowns were transplanted from a broadcasted stand in April, 1906, to rows 39 inches apart for the purpose of increasing the production of seed." (*Westgate.*)

25115. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

From Bromberg, West Prussia, Germany. Purchased from Mr. Ludwig Keller, Oberschüpf, Baden, Germany, who secured the seed from Rudolph Zawadski, in Bromberg, at the request of Mr. Charles J. Brand. Received March 18, 1909.

25116 to 25118.

From Pithoragarh, Kumaun District, India. Presented by Miss L. W. Sullivan. Received March 26, 1909.

Seeds of each of the following:

25116 and 25117. ORYZA SATIVA L. **Rice.**

25116. "*Jamal.* These seeds are first germinated by being placed in a basket set in a tub of water; when roots are about 1 inch long the seedlings are sown thick in a swampy place; when about 8 or 10 inches high like grass the small plants are separated and transplanted into a swampy place. We put the seeds to soak in May and harvest the grain in October." (*Sullivan.*)

25117. "This, our staple food (rice in husk), grows in ordinary soil during our rainy season when the ground is never dry. We sow in March and harvest in September. The fields are weeded three times." (*Sullivan.*)

25118. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

"*Bhat dal.*" A small, black variety of soy bean.

25119. MEDICAGO SATIVA L. **Alfalfa.**

From Vienna, Austria. Secured from Gebrüder Boschan, successors to Wieschnitzky & Clauser, Vienna, Austria, through Mr. Charles J. Brand. Received March 13, 1909.

25120. STIZOLOBIUM sp.

From Sibpur, Calcutta, India. Presented by Mr. A. T. Gage, superintendent, Royal Botanic Garden. Received March 29, 1909.

25121 to 25126.

From Brazil. Presented by Mr. William Hope, The Kenesaw, Washington, D. C., through Mr. W. W. Tracy, sr. Received March 25, 1909.

Seeds of each of the following:

25121 to 25123. CITRULLUS VULGARIS Schrad. **Watermelon.**

25121. Black seeded. **25123.** Red seeded.

25122. Black seeded.

25124 to 25126. CUCUMIS MELO L. **Muskmelon.**

25124. Long melon; yellow, wavy, smooth skin; yellow flesh; rind 1 centimeter.

25125. Long melon; yellow, wavy skin; white flesh; very little rind.

25126. Round melon; yellow, wavy skin; yellow flesh; rind 1 centimeter.

25127. CITRUS TRIFOLIATA L.

From Tsingtau, China. Received through Mr. Wilbur T. Gracey, United States consul, who procured the seed from Mr. Haas, head forester of the German Government at Tsingtau, March 29, 1909.

Procured for Mr. Walter T. Swingle's hybridization work.

25130 and 25131. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Knoxville, Tenn. Grown at the Agricultural Experiment Station. Received through Prof. H. A. Morgan, March 29, 1909.

Seeds of each of the following:

25130. Early brown.

25131. Medium yellow.

25132 to 25149.

From Soochow, Kiangsu, China. Presented by Rev. R. A. Haden, B. D. Received March 19, 1909.

The following seeds (quoted descriptions by Mr. Haden):

25132. DOLICHOS LABLAB L. **Bonavist bean.**

Black seeded. "Purple, flat bean; name from color of bloom, stalk, and leaves; all are purple. Eaten in green state, pod and all. Enormously productive in vine and leaf; not especially remarkable in the amount of fruit. Should be given plenty of room and vine supported."

25133 to 25137. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

25133. Small yellow. "Tom Thumb soy. The smallest variety; used only for bean sprouts."

25134. Large yellow. "Mammoth yellow soy. This is the very largest of the yellow soys. Used especially for oil and bean curd."

25135. Large green. "Tea green soy. Sutt variety. May be put to all the uses of the soy, but in practice they are only used to make parched Sutt beans, eaten as a relish."

25136. Large reddish brown. "Mammoth red soy. Used only for eating in the green state, but may be used for all the soy purposes. This is the largest of all the soys."

25137. Looks like *Meyer*. "Mammoth mottled soy. Used especially for bean curd; said to give a special flavor to this; has also abundant oil qualities."

25132 to 25149—Continued.

25138. Glycine soja Sieb. & Zucc.

"Horse-feed peas, a literal translation of the Chinese. It grows wild over a very large portion of China. In the north peas by the same name, but a different variety, are extensively cultivated. Long vines, climbing on anything in reach; fruited from bottom to top. I think this should receive special attention, for the following reasons: It will be a good nitrogen producer. It is extensively used in Chinese medicine, entering largely into prescriptions taken internally for eye trouble. It will make a better drink than anything except good coffee. Parch until brown the whole pea, grind, and treat as boiled coffee. This I have tried and am very fond of it as a drink."

Distribution.—An annual vine, native and cultivated in the eastern part of Asia, extending from Amur and Manchuria through China and eastern India; also in Japan.

25139 to 25141. Phaseolus angularis (Willd.) W. F. Wight.

25139. Red.

25140. Yellow.

25141. Mottled black.

"The uses of the above are the same as cowpeas, but the foliage is more abundant."

25142 and 25143. Phaseolus calcaratus Roxb.

25142. Red.

25143. Greenish yellow.

"From the shape of the seed these are called 'Crab-eye.' They are also the 'Lazy-man' peas, for the reason that they replant themselves. Growth rank; vine bunchy, not very long. Should be extra fine for renewing land and for fodder."

Distribution.—Native and cultivated in India and the Malay Archipelago, rising to an elevation of 5,000 feet in the Himalayas.

25144 to 25147. Vigna unguiculata (L.) Walp. **Cowpea.**

25144. Small red.

25145. Large red. "Vine rank, long, prolific; used especially for gruel."

25146. Reddish brown.

25147. Large brown eye.

25148 and 25149. Vigna sesquipedalis (L.) W. F. Wight.

25148. Reddish brown.

25149. Marked red and white.

25152 to 25160. Dolichos lablab L. **Bonavist bean.**

Grown at the Arlington Experimental Farm, Virginia, season of 1908. Numbered for convenience in recording distribution, March 30, 1909.

Seeds of each of the following:

25152 to 25155. Original seed presented by Dr. S. P. Barchet, Shanghai, China.

25152. (Agros. No. 0525.) A variety with white seeds. This variety at the Arlington Experimental Farm was very vigorous and very prolific; flowers white.

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25152 to 25160—Continued.

25152 to 25155—Continued.

25153. (Agros. No. 0522.) Very similar to No. 0525 (S. P. I. No. 25152). Seeds white, subglobose.

25154. (Agros. No. 0523.) Flowers pale purple; pods longer and narrower than any other variety; seeds large, dark purple, nearly black. A vigorous grower.

25155. (Agros. No. 0524.) A very prolific variety, with pink flowers and large purple-black seeds.

25156. (Agros. No. 0108.) Original seed obtained from J. M. Thorburn & Co., New York. A variety with small white seeds and white flowers. Very vigorous and prolific. One of the best under conditions at the Arlington Experimental Farm.

25157. (Agros. No. 0691.) Original seed obtained from Mr. A. W. Barlett, superintendent, Government Botanic Gardens, Georgetown, British Guiana. A variety with small, pure white seeds and white flowers. Very similar to No. 0108 (S. P. I. No. 25156).

25158. (Agros. No. 0425.) Original seed obtained from the island of Barbados. Seeds and flowers similar to the preceding (S. P. I. No. 25157), but plant not vigorous and leaves much affected with a spot disease.

25159. (Agros. No. 0438A.) A variety grown at the Arlington Experimental Farm, of unknown origin. Seeds small, brownish purple; flowers pink. Not vigorous nor prolific.

25160. (Agros. No. 0438B.) Similar to the preceding (S. P. I. No. 25159), with small, spotted seeds. Likewise of unknown origin.

25161. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Grown at the Arlington Experimental Farm, Virginia, season of 1908, under Agros. No. 0824. Numbered for convenience in recording distribution, March 31, 1909.

Eda. (?) Original seed from the Indiana Agricultural Experiment Station, where it was grown as *Early Brown*.

"This turned out to be identical with *Ito San* in every particular except color of seed. It is a uniform light brown, while *Ito San* is yellow. Neither superior nor inferior to *Ito San*." (*H. T. Nielsen.*)

25163 to 25165. **Ramboetan.**

From Buitenzorg, Java. Presented by Dr. M. Treub, Director of Agriculture. Received March 12 and 15, 1909.

25163. NEPHELIUM LAPPACEUM L.

"*Atjeh matjan.*"

Distribution.—A large tree, native of the Malay Archipelago, several varieties being cultivated.

25164. NEPHELIUM MUTABILE Bl.

"*Poelasan manis.*"

Distribution.—A native of the Malay Archipelago and of the islands of Java and Borneo.

25163 to 25165—Continued.

25165. NEPHELIUM LAPPACEUM L.

"*Atjeh Lebak boeloes.*"

Distribution.—A large tree, native of the Malay Archipelago, several varieties being cultivated.

"The ramboetan, or *Atjeh*, as the Dutch in Java call *Nephelium lappaceum*, is one of the showiest and one of the most delicately flavored of tropical fruits, superior to the Poelasan (*N. mutabile*). Although the mangosteen ranks first, in my mind, among all the tropical fruits of the world, there are many Dutch residents on the island of Java, where both of these fruits occur, who prefer the ramboetan to the mangosteen. I think even such a connoisseur as Doctor Treub would hesitate to decide which of these two fruits is the finest. The ripe fruits as sold on the markets in Java are about the size of a Japanese plum, but furnished with numerous weak protuberances. In color they are a handsome wine-red. The outer shell, or coating, is thick and leathery, but can be easily broken by a sharp twist of the hands. The flesh inside is much like that of the leitchee, to which it is a near relative, except that in general there is more of it and it is more delicately flavored, and it is my impression that as a rule it is juicier. So far as my limited experience goes with different varieties of leitchee, this ramboetan surpasses them all in excellence. I do not think the trees are cultivated in orchards, for very few orchards of any kind exist in Java. The trees are scattered through the kampongs, or little villages, all over the island. So far as I know, the ramboetan is not a grafted fruit, but grown only from seed. Owing to its thick rind, the fruit of the ramboetan should be a good shipper, and if the plants can be grown on the Panama Canal Zone, in Porto Rico, or southern Florida they should make a decided sensation when they are first offered for sale on our markets." (*Fairchild.*)

25166. CUCUMIS MELO L. **Muskmelon.**

From Peleka, Corfu Island. Presented by Mr. Carlo Sprenger, Vomero, near Naples, Italy. Received March 30, 1909.

"Seed of a splendid winter melon. Flesh white or greenish white; shell golden yellow. Very fine and never seen before." (*Sprenger.*)

25167 and 25168.

From Erfurt, Germany. Received from Mr. N. L. Chrestensen, Thüringer Central-Saatstelle, Erfurt, Germany, through Mr. Charles J. Brand, March 15, 1909.

Seeds of the following:

25167. MEDICAGO SATIVA L. **Alfalfa.**

Deutsche blaue. "(P. L. H. No. 3417.) This strain of alfalfa is said to be very resistant to severe, snowless winters, and to endure a long series of years. It is produced on exposed situations in Thuringia." (*Brand.*)

25168. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

Böhmische. (P. L. H. No. 3418.)

25169 to 25171.

From Portuguese East Africa. Presented by Mr. O. W. Barrett, Director of Agriculture, Lourenço Marquez. Received March 30, 1909.

The following seeds:

25169. Anona senegalensis Pers.

"(No. 23.) A small tree, wild near Lourenço Marquez. Fruit 2 to 4 inches long, yellowish skin, bright yellow pulp. Edible. Shironga (Kafir) name *M'zhampfo* or *Mazhópfa.*" (*Barrett.*)

Distribution.—A low shrub or small tree, native to the tropical region of Africa, extending from Guinea and the upper valley of the Nile south to the Zambezi Valley.

25170. Strychnos spinosa Lam. **Kafir orange.**

"(No. 24.) A tree 15 to 25 feet high, in bush veld from Zululand to Rhodesia. Fruit spherical, 2 to 3 inches in diameter, yellow when ripe, hard shelled. Edible. Flavor like 'cinnamon and pears.' Shironga (Kafir) name *M'sála.*" (*Barrett.*) See No. 9611 for the original importation and description.

Distribution.—A small tree native to the tropical region and the southern part of Africa and also in the Seychelle Islands and in Madagascar.

25171. Vangueria infausta Burch.

"(No. 25.) A small tree near Lourenço Marquez, in sandy soil. Fruit roundish, flattened distal. Edible; pulp dry, sweet. Shironga (Kafir) name *M'pfilo.*" (*Barrett.*)

Distribution.—A native of the southeastern part of Africa, being found in the vicinity of Johannesburg and of Natal, and in the eastern part of Cape Colony.

25172 to 25174. Medicago spp.

From farm of Mr. Lewis Brott, Sextorp, Nebr. These three lots were grown in cultivated rows, 42 inches apart, for seed and were open to the possibilities of cross-pollination among themselves. The Turkestan alfalfa was separated from *Brott's Dry-Land* alfalfa by 14 rows of sand lucern. Seed collected by Mr. J. M. Westgate, August 15, 1908.

Seeds of the following:

25172. Medicago sativa L. **Alfalfa.**

Brott's Dry-Land. "From same stock as S. P. I. No. 19566, grown in row adjacent to row of sand lucern (S. P. I. No. 20457) and presumably cross-pollinated with the same." (*Westgate.*)

25173. Medicago sativa varia (Mart.) Urb. **Sand lucern.**

"Grown from S. P. I. No. 20457 in row adjacent to *Brott's Dry-Land* alfalfa." (*Westgate.*)

25174. Medicago sativa L. **Alfalfa.**

Turkestan. "Grown from S. P. I. No. 18751 in row adjacent to sand lucern (S. P. I. No. 20457)." (*Westgate.*)

25175 and 25176. Medicago spp.

From Berlin, Germany. Secured from J. & P. Wissinger, Samenhandlung, Berlin, Germany, through Mr. Charles J. Brand. Received March 24, 1909.

25175 and 25176—Continued.

Seeds of the following:

25175. MEDICAGO SATIVA L. **Alfalfa.**

Alt-Deutsche Fränkische lucern. "(P. L. H. No. 3420.) This alfalfa usually has a very large percentage of hard seed, in some samples as high as 63 per cent failing to germinate in the five-day germination test. On this point Wissinger says: 'We could bring the seed to greater germinating power by scratching, were it not for the fact that the hardness of shell is thought here to be a desirable quality under certain conditions. Indeed, it is believed that the longevity of a stand of Franconian lucern is due to its hard-shelled seeds, some of which often lie dormant for years, thereby constantly rejuvenating the stand with a fresh supply of young plants. The appearance of this seed, as furnished, is not first class. We would not, however, wish to do anything that would impair its originality.'

"The present sample was grown in Iphofen, Franconia." (*Brand.*)

25176. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

Bohemian. "(P. L. H. No. 3421.) This seed was grown on the right bank of the Elbe in Bohemia." (*Brand.*)

25177. TRIFOLIUM SUAVEOLENS Willd. **Shaftal.**

From Amritsar, Punjab, India. Secured from Mr. Philip Parker, experimental officer in the Indian Irrigation Secretariat, through Mr. Charles J. Brand. Received April 1, 1909.

"Shaftal, which is an annual plant, is the chief fodder crop in the valleys of the northwest frontier of India. It is always grown with irrigation and gives exceedingly good yields.

"Experiments begun in 1907 with the seed previously presented by Mr. Parker (S. P. I. Nos. 19506 and 19507) have proceeded far enough to show considerable promise for this clover, especially in our hot irrigated valleys." (*Brand.*)

25178 and 25180. MEDICAGO spp.

From Vienna, Austria. Secured from Gebrüder Boschan, successors to Wieschnitzky & Clauser, through Mr. Charles J. Brand. Received March 25, 1909.

The following seeds:

25178. MEDICAGO SATIVA VARIA (Mart.) Urb. **Sand lucern.**

Böhmische. (P. L. H. No. 3428.)

25179. MEDICAGO SATIVA L. **Alfalfa.**

Ungarische. (P. L. H. No. 3429.)

25180. MEDICAGO SATIVA L. **Alfalfa.**

Mährische. (P. L. H. No. 3430.)

25181 to 25185. MEDICAGO SATIVA L. **Alfalfa.**

From Bonn-Poppelsdorf, Germany. Presented by Prof. Dr. Th. Remy, director, Institut für Bodenlehre und Pflanzenbau der Königlichen landwirtschaftlichen Akademie, Bonn am Rhein, through Mr. Charles J. Brand. Received March 25, 1909.

The following seeds:

25181. *Pfalzer.* (P. L. H. No. 3422.) Original seed from Frankenthal, Rhein-Pfalz, Germany.

25181 to 25185—Continued.

25182. *Eifeler.* (P. L. H. No. 3423.) Original seed from Bitburg, in the Eifel, Prussia.

25183. *Alt-Fränkische.* (P. L. H. No. 3424.) Original seed from Lagerhaus für das Frankenland, Tauberbischofsheim, Baden, Germany.

25184. *Provenzer.* (P. L. H. No. 3425.) Original seed grown near Trier, in the Moselthal of Prussia.

25185. *Ungarische.* (P. L. H. No. 3426.) Original seed grown at Csorvas, Komitat Bekes, Hungary.

25186 to 25190.

From Pisa, Italy. Presented by Prof. G. E. Rasetti, director, Cattedra Ambulante di Agricultura per la Provincia di Pisa, Italy, through Mr. Charles J. Brand. Received March 31, 1909.

The following seeds:

25186 and 25187. MEDICAGO SATIVA L. **Alfalfa.**

25186. (P. L. H. No. 3431.) Grown near Setif, Algeria.

25187. (P. L. H. No. 3432.) *Herba medica.* The form commonly grown in Italy. This sample was produced near Pisa, Italy.

25188 to 25190. TRIFOLIUM PRATENSE L. **Red clover.**

25188. (P. L. H. No. 3433.) "Professor Rasetti states that this variety is known as *Spadone*, and that it was produced at Santhia, in the province of Novara, Italy." (*Brand.*)

25189. (P. L. H. No. 3434.) This is the form commonly cultivated in Italy. Gathered near Pisa, Italy.

25190. (P. L. H. No. 3435.) This variety is known as *Vische*, and is cultivated in Vische, in the province of Novara.,

25191. MEDICAGO SATIVA L. **Alfalfa.**

From Chico, Cal. Seed collected by Mr. Roland McKee at the Plant Introduction Garden, July 13, 1908. Numbered for convenience in recording distribution, March, 1909.

"This seed was collected from a single plant grown from S. P. I. No. 19508. Mother plant possessed flowers borne in compound racemes. The flowers were open to the visits of insects and were presumably cross-pollinated with pollen from the numerous other lots of alfalfa in the alfalfa nursery." (*J. M. Westgate.*)

"This plant was noticed by me on May 1, 1908, while walking over the grounds of the Plant Introduction Garden at Chico, Cal., with Mr. Roland McKee. The plant was noticeable even from a distance because of the profusion of its flowers. Upon examination this was found to be due to the fact that the flower clusters were much branched instead of being simple as usual.

"As the plant seemed healthy and vigorous in spite of its profusion of flowers, it seemed desirable to direct attention to it with a view to obtaining a new variety—perhaps able to produce a better quality of hay and also more seed than the ordinary plants of the parent strain." (*W. T. Swingle.*)

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 163.
B. T. GALLOWAY, *Chief of Bureau.*

VARIETIES OF AMERICAN UPLAND COTTON.

BY

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Issued February 25, 1910.

239488
13 1 30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

BUREAU OF PLANT INDUSTRY.

Chief of Bureau, Beverly T. Galloway.
Assistant Chief of Bureau, G. Harold Powell.
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., July 9, 1909.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 163 of the series of this Bureau, the accompanying manuscript, entitled "Varieties of American Upland Cotton." This paper was prepared by Mr. Frederick J. Tyler while Scientific Assistant in Fiber Investigations, Bureau of Plant Industry, and has been submitted by the Botanist in Charge.

There has long been a demand from cotton planters, and especially from men engaged in breeding cotton plants or in maintaining improved varieties, for accurate descriptions of the varieties now recognized, together with information as to the history, relationships, and classification. In response to this demand the results of three years of careful study of growing plants in the field, thousands of measurements and tests of lint and seeds in the laboratory, and a study of all the literature available relating to American Upland cotton varieties are here brought together.

It is hoped that this bulletin may not only serve as a record of the characters and distribution of the varieties now recognized, but that it may also stimulate an interest in the development and perpetuation of varieties having definite improved characters, such as strength of fiber, uniform length of staple, resistance to injury by storms, adaptability to particular types of soil, and other desirable qualities aside from yield.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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VARIETIES OF AMERICAN UPLAND COTTON.

INTRODUCTION.

Two species of cotton are cultivated in the United States. These are American Upland cotton (*Gossypium hirsutum* L.) and Sea Island cotton (*Gossypium barbadense* L.). American Upland cotton, through misidentification, has been referred by American authors to *Gossypium herbaceum* L., but recent studies have shown conclusively that it is very distinct from the Asiatic cottons, of which *G. herbaceum* is a representative species. It is really more closely related to the Sea Island cotton. Both species cultivated in this country originated in tropical America.

Sea Island cotton (*Gossypium barbadense* L.) yields a very fine, long, and silky staple, but can be grown commercially only in a limited area near the coast of South Carolina, Georgia, and Florida. Partly because of this narrow geographical range but more on account of the fact that breeders of Sea Island cotton have been working toward one and the same end—a still better staple—the species has not been split up into distinct types or groups of varieties.

Upland cotton (*Gossypium hirsutum* L.), which is the species dealt with in this bulletin, forms more than 99 per cent of the cotton crop of the United States. The improvement of this species has progressed along several different lines according to the necessities or individual preferences of the grower, and very distinct types have been developed, such as the stormproof cottons of Texas, the early cottons of North Carolina and Tennessee, and the long-staple varieties of the Mississippi Valley. These diverse types have led some to consider Upland cotton a composite of different species, and a recent author[a] intimates that no less than seven distinct species were concerned in its evolution.

One variety[b] is known which can, indeed, be traced back to a hybrid origin, and it is possible that the excellent lint of some of the long-staple varieties of the Mississippi Valley is due to a slight admixture of Sea Island blood. The great majority of Upland varieties, however, are of pure stock, and it seems probable that this stock originated in Central America, where it has been cultivated since prehistoric times.

---

[a] Watt, Sir George. Wild and Cultivated Cotton Plants of the World. 1907. Here varieties of Upland cotton are referred wholly or in part to the following species: *G. arboreum neglectum* Watt, pp. 100-102; *G. barbadense* L., p. 194; *G. herbaceum* L., p. 163; *G. mexicanum* Tod., p. 226; *G. punctatum jamaicum* Watt, pp. 182, 233; *G. purpurascens* Poir., pp. 232, 354; *G. schottii* Watt, pp. 209, 233.

[b] Coxe Yellow-Bloom.

Each of the different groups just mentioned contains a number of closely related forms, difficult to distinguish, which are commonly called varieties but which are for the most part analogous to the "strains" of the horticulturist. It will often be noticed that, on account of the marked adaptability of cotton to soil and climate, varieties hardly distinct in other ways are fitted for different agricultural conditions, and other distinctive characters, such as a better staple and a higher percentage of lint, may also be present but are not apparent until the variety is more closely studied.

The large number of named varieties and the uncertainty as to the classification of many of them, as well as the misleading statements sometimes published concerning the commercial varieties, make it necessary to describe and classify them as accurately as possible and to map, or otherwise state, their distribution.

ORIGIN OF UPLAND VARIETIES.

Varieties are usually developed by what is called "mass selection." The breeder goes through his fields before picking time and marks the plants which conform to his ideal. The seed cotton from these select plants is then picked and ginned by itself, and in this way the seed for the next year's planting is obtained. Usually, only one or two characters are specially desired, as, for instance, large bolls combined with prolificacy, and while the resulting plants may be fairly uniform in the desired characters they will vary greatly in others. Except in regard to their peculiar characteristics, varieties developed by mass selection can only be described in a general way and by average results.

Several of our standard varieties, as, for example, the Russell and the Rowden, have been developed by the opposite method of "isolation." Here the progeny of a single plant which was so distinct as to attract the breeder's attention is made the basis of a new variety, often without further selection. The seed of this plant is saved separately and planted by itself in an isolated seed patch until sufficient seed is obtained to plant the entire crop. If the plant originally selected was of pure blood the variety developed from it will be very uniform in all characters, but instances are known[a] where the original selection was a cross between quite dissimilar parents and a portion of the progeny tended to revert to either parent stock, making the variety more diverse than one developed by mass selection. Of the two methods, isolation unquestionably gives quicker and more uniform results if carried on carefully and intelligently.

---

[a] Cook's Improved, for example.

STABILITY OF VARIETIES.

From the nature of the crop, cotton varieties are more difficult to keep pure than those of other farm crops. The seed cotton is usually hauled to a public gin, and the cleaned seed is allowed to run into a bin containing seed from several other farms. Even if care is taken to keep the seed separate, some mixing will occur, from the fact that the gin has not been thoroughly cleaned out and a new roll started, it being impracticable at a public gin to take the time and trouble necessary to keep the seed entirely pure. For the reason that insects carry pollen from flower to flower, mixing may readily occur if different varieties are grown in adjacent rows or fields. Probably a majority of the flowers are close-fertilized, that is, fertilized with their own pollen, but quite enough are cross-fertilized to make this an important source of contamination when varieties are grown in close proximity.

It is generally believed that an improved variety will degenerate gradually unless consistent selection is carried on every year. A large part of the degeneration is due to mixture of seed, but possibly the increase of undesirable plants within the variety aids in lowering the standard. The average farmer does not have the time or the opportunity to keep a pure stock of improved seed and depends on buying seed from time to time from the originator or from some one interested in keeping the variety up to the standard. The stability of a variety thus depends very largely on the continued careful work of the originator, to whom a private gin is almost a necessity although a few varieties have been built up and kept pure by breeders who have not had this advantage.

INFLUENCE OF SOIL AND CLIMATE.

It has long been recognized by growers that when a variety is first tried in a new locality and soil it may prove disappointing until acclimated.[a] The process of acclimation usually takes two or three years and affects the variety as a whole. But there is a difference in the ability of varieties to become adjusted quickly to new conditions.[a] King's Improved, or Sugar-Loaf, has been tried in all parts of the cotton belt during the past ten years and has made satisfactory yields from the first, though rarely equaling those of the best local varieties. On the other hand, some varieties are specialized, or, in other words, especially fitted to certain conditions of soil and climate, and make very poor yields when tried in new localities. Acclimation in this case would mean the entire readjustment of the variety. Examples of such can usually be found in the results of variety tests published by the state agricultural experiment stations, where cottons well and favorably known at home are placed near the foot of the list on account of poor yields under the conditions given them on the station farm. Beat-All, a popular variety in some parts of southern Georgia, is a good illustration. Growers who are well acquainted with its merits state that it is particularly successful as a poor-land cotton. It is a large-growing variety, requiring the entire season to mature its crop, and is probably able to utilize the small and slowly available store of plant food in poor soil to much better advantage than would be a quick-growing, early-maturing cotton. When tested on the rich, well-cultivated soil of the station farm at Experiment, Ga., but under almost its accustomed climatic conditions, it stood twenty-fourth in 1906 and twenty-sixth in 1907, and in point of yield was considered one of the poorest varieties tested.

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[a] See Report of the United States Patent Office for 1850, p. 263. Mr. M. W. Phillips, of Edwards County, Miss., here states that the poor yield of a variety known as Vick's 100-Seed "may be caused by all my seed being fresh from Deer Creek, where Col. H. W. Vick, the spirited selector of this variety, plants. I sold out all my own seed, with a view of getting a fresh stock, which was a damage to my general crop. Fresh seed has never here given so good a crop."

While the variety tests of experiment stations are based primarily upon the yield or total value of products, which as a rule is the most important character, other qualities, such as size of boll and of seed and length and percentage of lint, are noticed by some of the stations, and these qualities are also found to vary considerably in different localities. The interesting fact has been observed that the entire variety test varies en masse as regards some of these qualities. Unfortunately, it is not possible to obtain much information upon this point from the reports of the various experiment stations, even when a particular variety was tested by two or more stations during the same season, since the source of seed was rarely the same, one station, perhaps, planting fresh seed obtained from the originator and another planting seed grown the year before on the station farm. Reliable measurements of average bolls of three varieties have been obtained by the North Carolina state board of agriculture for three locations within that State during the same seasons.[b] It required 54 bolls of the Russell variety to weigh a pound when grown at Edgecombe Farm, Rocky Mount; 64 at Red Springs Farm, Red Springs; and 72 at Iredell Farm, Statesville. Of the Culpepper variety it required, respectively, 61, 71, and 74; and of the Edgewood 72, 77, and 79. In each case the bolls were smallest at Iredell Farm, intermediate at Red Springs Farm, and largest at Edgecombe Farm. The average percentage of lint of four varieties was found to be invariably higher at Red Springs Farm than at Edgecombe Farm.

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[a] See "Weevil-Resisting Adaptations of the Cotton Plant," Bulletin 88, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1906, p. 17, and "Local Adjustment of Cotton Varieties," Bulletin 159, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909.

[b] See Bulletin 9, North Carolina State Board of Agriculture, vol. 27, p. 25.

In the spring of 1907 several varieties of cotton seed were sent out in the congressional seed distribution of the United States Department of Agriculture and were grown by four of the state experiment stations. Tests of the crop grown from this seed were made, and the results are shown in the following table:

TABLE I. - *Results of tests of several varieties of cotton, showing the relative number and size of bolls and seeds, the percentage of lint to seed, and the length and strength of the lint when the plants were grown in different States.*

Variety.	Bolls per pound.				Seeds per pound.				Percentage of lint.			
	La.	Ala.	Ga.	Tex.	La.	Ala.	Ga.	Tex.	La.	Ala.	Ga.	Tex.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Cook's Improved	58	61	64	90	3,650	4,025	3,860	4,160	38.3	36.7	39.3	30.9
Corley Wonderful	48	54	58	70	2,670	2,835	3,260	3,780	31.9	29.8	35.8	31.3
Gold-Standard	74	82	92	105	4,050	5,050	5,380	5,060	33.5	35.8	39.6	31.7
Pride of Georgia	53	61	68	71	3,540	3,630	3,700	3,660	30.0	32.4	33.2	31.2
Sunflower	78	90	98	119	4,160	4,970	5,260	4,620	29.0	30.6	31.5	25.4
Average	62	70	76	91	3,614	4,102	4,292	4,256	32.5	33.1	35.9	30.1

Variety.	Length of lint.				Strength of lint.			
	La.	Ala.	Ga.	Tex.	La.	Ala.	Ga.	Tex.
	Mms.	*Mms.*	*Mms.*	*Mms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*
Cook's Improved	21.8	22.8	21.6	23.6	6.2	6.5	7.8	5.9
Corley Wonderful	23.2	23.1	23.8	23.6	6.8	7.0	6.7	7.3
Gold-Standard	22.9	22.0	22.3	23.0	6.1	....	5.8	6.4
Pride of Georgia	23.3	23.0	24.2	22.4	6.5	6.3	6.1	5.8
Sunflower	32.8	27.7	33.0	30.7	4.8	4.4	4.0	4.6
Average	24.8	23.7	25.0	24.7	6.1	6.1	6.1	6.0

It will be seen that in nearly every instance and with remarkable unanimity the bolls are very small at College Station, Tex., of medium size at Experiment, Ga., somewhat larger at Auburn, Ala., and very large at Baton Rouge, La. The size of seed follows closely the size of boll. The length and strength of lint varied to some extent in the individual varieties, but very little en masse, the strength of lint being slightly lower at Baton Rouge, La., due to the damp and unfavorable weather which prevailed at picking time. The percentage of lint varied to an interesting degree, being highest without exception at the Georgia station and usually lowest at the Texas station.

TERMS USED IN DESCRIPTIONS.

LIMBS AND FRUITING BRANCHES.

Upland cotton has two very distinct forms of branches.[a] There are usually two or three heavy branches, or limbs, arising from near the base of the plant, which are homologous to the main stalk. These bear leaves, but never flowers and fruit, and have been called sterile or wood limbs. From them, and also from the main stalk, other branches arise which bear leaves and, normally, flowers and fruit at each joint. The limbs, as they will be termed in this bulletin, are always heavier and stronger than the fruiting branches and tend to grow up, while the latter grow out horizontally or even droop. Another important difference is most apparent in the cluster and semicluster cottons, where the fruiting branches are often reduced to mere spurs, due to a shortening of the internodes, while the limbs are not affected but are as long as would be expected in a plant of the same height with normal fruiting branches.

The nodes or joints of the main stem are about 2 inches apart, more in tall-growing varieties and less in dwarf varieties, so that there are about the same number of joints in each, from 16 to 20. Bennett [b] has shown that the distance between the joints of the stalk, and especially of the fruiting branches, has an important bearing on the time of maturity, and the term "short-jointed cotton" within the last few years has become almost synonymous with "early cotton."

FLOWER AND INVOLUCRE.

The flower is of little service as a distinctive character. One variety, known as "Coxe Yellow-Bloom," bears flowers of clear lemon-yellow instead of the creamy white color that is almost universal in the species. This peculiarity has also been noticed in some of the Upland varieties long acclimated in India. King or Sugar-Loaf cotton and its derivatives are well marked by a red spot at the base of the petals, but this marking is indistinct or lacking in about 50 per cent of the flowers of these varieties. It is also found in some of the varieties of Upland cotton cultivated from prehistoric times by the Indians of Guatemala. Some varieties of long-staple cotton, such as the Sunflower, the Floradora, and the Allen, bear anthers and pollen of a rich yellow color, but a small number of plants, from 5 to 10 per cent, in each of these varieties produce the usual cream-colored pollen, and a few plants will be found in the varieties of other groups which bear yellow pollen.

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[a] See Cook, O. F., Weevil-Resisting Adaptations of the Cotton Plant, Bulletin 88, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1906, p. 19.

[b] Bennett, R. L. Farmers' Bulletin 314, U. S. Dept. of Agriculture, 1908.

The involucre consists of a whorl of three green, leaf-like bracts just below the flower, which protect the bud and young boll to some extent and are of service in building up the stormproof character of Texas cottons. However, as the involucre dries and becomes brittle soon after the boll opens, it is often torn off by careless pickers and forms a large part of the trash that lowers the grade of lint.

BOLL, LOCULES, AND LOCKS.

The boll or seed capsule splits into 3, 4, or 5 locules or segments when ripe, exposing the seed cotton, which is more or less matted together into as many locks as there are locules in the boll. The shape of the boll varies from nearly spherical to long and pointed. The size also varies greatly in different cottons and is best measured by weighing the yield of dry seed cotton. Other characters are the variations in thickness of the shell of the boll and the stormproof characters described later.

LENGTH OF LINT.

The cotton fiber, which is known as the lint, staple, or floss, varies in fineness and length in different cottons, the maximum variation between the short-staple and the long-staple varieties being nearly an inch.

There are several methods of determining the length of lint, but the one which seems to be most accurate and which has been employed by the Department of Agriculture is as follows:

From ten to twenty locks are selected from the sample to be tested and a single seed picked out from near the center of each lock. The seed is then combed "butterfly shape" and a tuft of fiber plucked from near the middle of one side and laid out upon a pad of black velveteen, the pile of this cloth tending to keep the fibers straight. The base of the tuft is pressed firmly against the velveteen with the thumb, while the fibers are combed out smoothly with a small pocket comb. This not only straightens them to their full length, but it also removes overlapping fibers, which would give erroneous measurements, especially in long-staple cottons. With the back of a pair of curved forceps a line is then drawn at each end of the tuft, excluding the fringing ends and marking as nearly as possible the average length. The distance between these lines is then measured with a millimeter[a] scale. (See Pl. I, fig. 1.) The measurements given show the average rather than the extreme lengths, and thus are often shorter than measurements made in the usual manner from ginned cotton, as the repeated pulling methods then employed are designed to eliminate all of the shorter fibers and only the length of the longest fibers is given.

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[a] One millimeter equals 0.03937 inch, or nearly 1/25 inch; 25.4 millimeters equal 1 inch.

STRENGTH OF LINT.

The strength of lint depends partly upon the weather conditions and the treatment the seed cotton receives at picking time and partly upon the variety,[a] long-staple cottons as a rule yielding rather weak lint. In our tests the strength of lint has been obtained by the use of a standard fiber-testing machine, which tests but one fiber at a time. (See Pl. I, fig. 2.) The fiber is singled out from near the middle of the seed,[b] placed in clamps grasping it firmly near each end, and subjected to a gradually increasing strain until it breaks, the breaking strain being recorded in grams. Twenty such tests are made from each sample and the average recorded as the strength of single fibers.

COLOR OF LINT.

There is but little variation in the color of lint, all of the commercial varieties yielding a creamy white staple, which bleaches to dead white if exposed too long to sun and rain in the field. A cotton known as "Nankeen" was formerly grown for home use which yielded a handsome khaki, or yellowish brown lint, but with the passing of home spinning this variety has also disappeared from cultivation. A variety called "Texas Wool" which yields a light-green lint, soon fading to a dingy brown when exposed to the weather, was tested but was found to be valueless except as a curiosity.

PERCENTAGE OF LINT.

The proportion of lint to seed in seed cotton is next to yield the most important economic varietal character and, furthermore, it is easily influenced by careful selection.[c] The percentage is usually determined by ginning an average sample by hand and weighing the lint and seed separately upon accurate balances. When the sample is small this has been found to give more exact results than machine ginning. The maximum variation in proportion of lint among commercial varieties amounts to nearly 20 per cent.

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[a] See the Bulletin of the North Carolina Department of Agriculture, September, 1906, where it is stated that the oil content of the seed bears a definite relation to the strength of lint.

[b] A large number of tests were made of fiber from the ends and side of the seed, both of long and short staple, with the following average results: Breaking strain of fibers from the side of the seed, 6.34 grams; from the pointed end, 5.52 grams; and from the round end, 4.62 grams. Also see the Agricultural News, Barbados, vol. 5, no. 101, p. 71.

[c] Recent investigations indicate that the importance of a high percentage of lint may be overestimated. See "Danger in Judging Cotton Varieties by Lint Percentages," Circular 11, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1908.

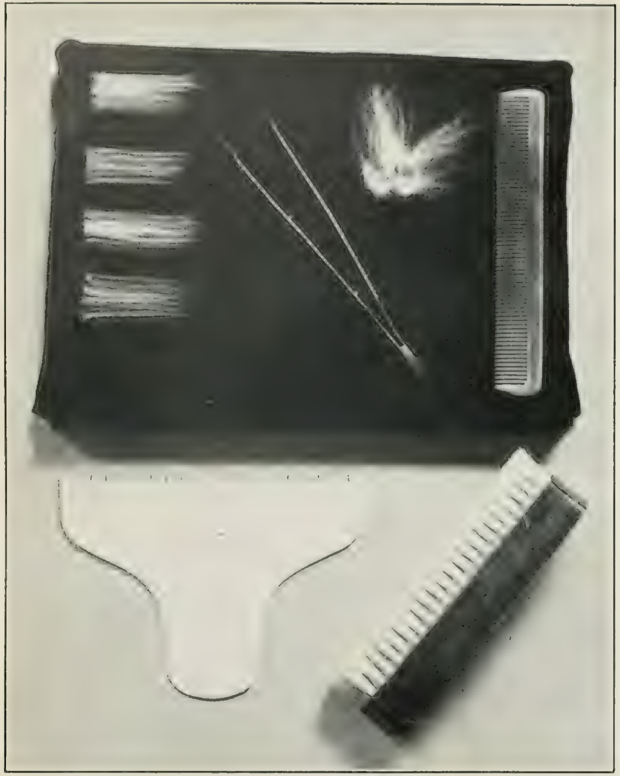

FIG. 1.—IMPLEMENTS USED IN MEASURING THE LENGTH OF COTTON STAPLE.

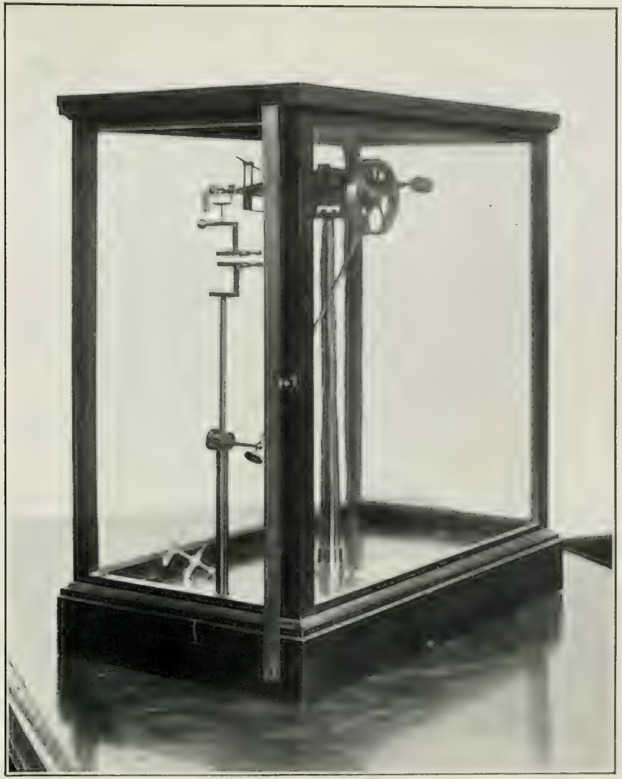

FIG. 2.—APPARATUS USED IN DETERMINING THE STRENGTH OF COTTON FIBER.

IMPLEMENTS AND APPARATUS USED IN MEASURING AND TESTING COTTON FIBER.

SEED.

When the lint is ginned from the seed another covering is found beneath, a short velvety coat called the "fuzz," which varies in color from dark olive-green and brown to ashy gray or white. It also varies in length from one thirty-second to one-fourth inch and in quantity from very dense to rather thin, often being absent entirely except at one or both ends of the seed, where a small tuft of fuzz is generally persistent. A few entirely naked seeds are found in most varieties and this character can be fixed by selection, but it seems undesirable for the reason that a good percentage of lint is apparently correlated with the presence of fuzz. It is a general belief among cotton planters and breeders, both of Upland and of Sea Island varieties,[a] that entirely naked seeds should be picked out and discarded from choice seed intended for planting.[b] The fuzz is of some value and is removed at the oil mills, forming a portion of the material sold as "linters."

The maximum variation in size of seed is considerable, the smallest seeds, Bates Little Brown-Seed, averaging 0.07 gram apiece, or 6,480 to the pound, while the largest, Best-Crop, weigh 0.178 gram apiece, or 2,550 to the pound. This seems to be the greatest permissible difference from an economic standpoint, for the larger seeded varieties are usually deficient in percentage of lint, while the smaller seed is low in vitality and requires more favorable weather and soil conditions at planting time. The oil content of the seed varies from 16 to 23 per cent, or from 37.26 to 42.02 per cent of the kernel. It is not at present a distinct varietal quality, but can be influenced by selection.[c]

TIME OF MATURITY.

The time of maturity is an important varietal quality, especially in the northern third of the cotton belt and in weevil-infested regions everywhere. The growing of early varieties has been found one of the best means in the Southwestern States of combating the weevil, plants of this type being able to put on a fair crop before the weevils become plentiful enough to do much injury. The earliest varieties now in cultivation begin ripening in ninety days after planting, and by selection a variety has been obtained which ripens its crop and then dies, instead of continuing alive until killed by frost, as do most varieties. This early-dying character is of little value in the extermination of the weevil, however, unless varieties of this kind are grown exclusively in large areas, as the other varieties will serve as feeding places for the weevils until they hibernate for the winter.

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[a] See Farmers' Bulletin 302, U. S. Dept. of Agriculture, p. 36; also Agricultural News, Barbados, vol. 5, no. 101, p. 71.

[b] To test the truth of this belief two samples of seed cotton of the Gold-Standard variety were picked from the same row, one with the usual fuzzy seeds and the other with seeds entirely naked. The former yielded 39.6 per cent of lint, the latter only 28.3 per cent.

[c] See North Carolina State Board of Agriculture Bulletin for September, 1906, p. 13.

PRODUCTIVENESS.

No attempt has been made in this bulletin to give the relative yield of varieties, although it is a character of prime importance. All varieties cultivated for profit are productive when grown under the conditions to which they are suited, and it is manifestly unfair to grow a hundred varieties, developed under as many different conditions, on a single farm, to which only a few may be best suited, and consider the results applicable to the entire cotton belt. The variety tests conducted by the different state experiment stations are unreliable as far as yield is concerned for an area as large as a State, and in some cases the results may not apply to the adjoining farm, owing to the different methods of fertilizing and culture pursued. For this reason the question of productiveness is better left to the individual farmer to solve on his own farm under local conditions.

CLASSIFICATION OF VARIETIES.

Several schemes of grouping or classifying Upland cottons have been proposed, but since they are usually based on some arbitrary and variable character, such as the presence or absence of fuzz on the seed or the habit of growth, they are of little value. Duggar's classification, which with some changes has been adopted in the work of the Department of Agriculture, is an exception, as it is based, so far as possible, on the natural relationship of the varieties. In this classification eight divisions were made, as follows: Big-boll, long-staple, cluster, semicluster, early or short-limb, long-limb, Peterkin or Rio Grande, and intermediate groups.

BIG-BOLL GROUP.

The essential character of the big-boll group is the size of boll, or, to be more exact, the weight of dry seed cotton contained in the boll. The maximum size of boll in this group is at present about 11.5 grams, or from 38 to 40 bolls to the pound, and the minimum size has been arbitrarily fixed at 6.5 grams, or 68 bolls to the pound. The plants are stocky and usually vigorous; limbs strong and heavy, usually 2 in number; fruiting branches quite strong, ranging from very short and irregularly jointed or semiclustered to very long jointed; leaves large, becoming almost glabrous, lobes broad and short; bolls large, with 4 or 5 locules; seeds large, fuzzy, dark green,

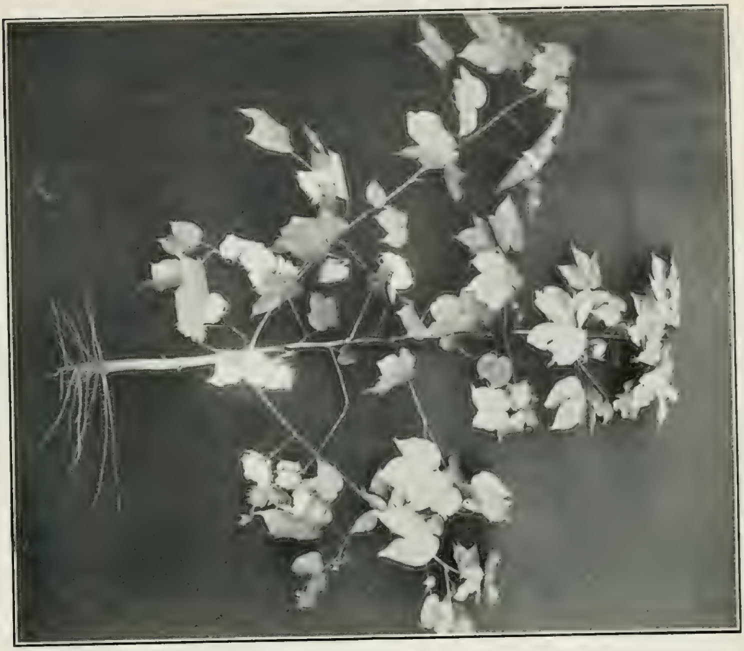

FIG. 1.—PLANT OF THE WYCHE VARIETY.

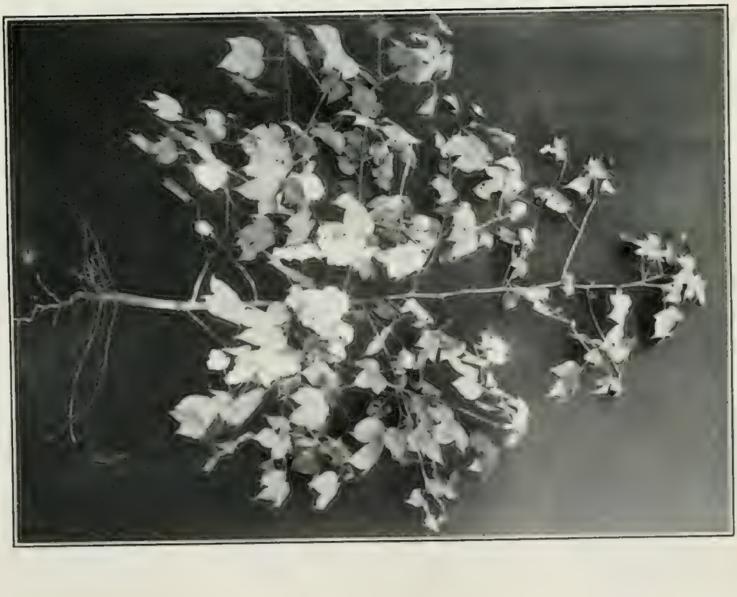

FIG. 2.—PLANT OF THE TRUITT VARIETY.

TYPES OF THE BIG-BOLL GROUP OF COTTON.

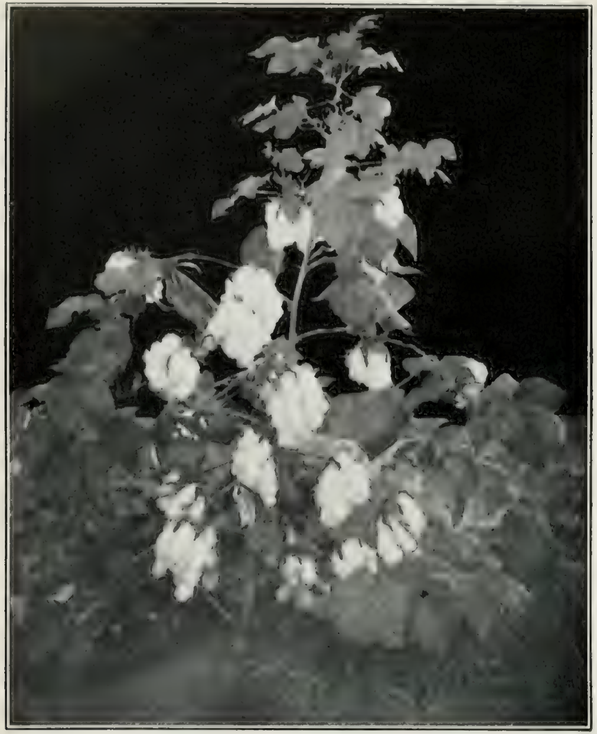

FIG. 1.—PLANT OF THE TRIUMPH VARIETY.

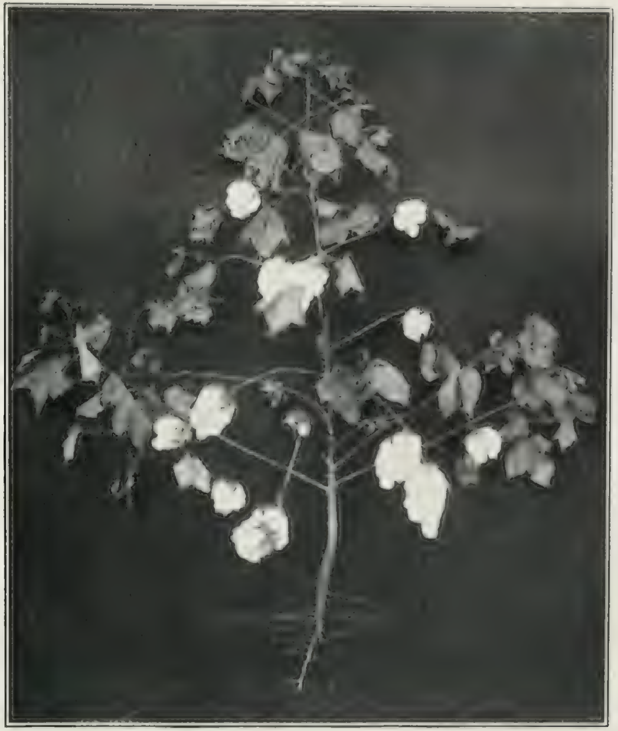

FIG. 2.—PLANT OF THE ROWDEN VARIETY.

TYPES OF THE BIG-BOLL STORMPROOF GROUP OF COTTON.

greenish or brownish gray or white; lint short to medium, 20 to 30 mm. in length, soft, and of good strength, usually $33\frac{1}{3}$ per cent or more. (See Pl. II, figs. 1 and 2.)

STORMPROOF GROUP.

A subdivision of the big-boll group has been developed on the Plains west of the Mississippi, where severe wind and rain storms are frequent during the picking season. It is known as the big-boll stormproof group and includes some of the most highly developed varieties grown at the present time. The plant is vigorous, upright in growth during the first part of the season, but later drooping under the weight of bolls. The bolls are not borne upright upon the branch, but lie close to it, the peduncle or stem of the boll forming an acute angle with the branch. When the stem and fruiting branches are bent down, the bolls are inclined or inverted, so that when ripe the broad thick segments of the bur and the unusually large involucres form a more or less perfect roof above the locks of seed cotton which hang down underneath and coalesce into a single mass. The locks are also more securely attached to the bur, but as a rule the stormproof cottons are easier to pick than varieties with locks more readily dislodged. (See Pl. III, figs. 1 and 2.)

LONG-STAPLE GROUP.

The long-staple group is a rather arbitrary division, based on the length and fineness of the lint, which varies from 30 to 45 mm. ($1\frac{3}{16}$ to $1\frac{3}{4}$ inches) in length. A few varieties, such as the Flemming, the Moon, the Griffin, and the Columbia, have been developed from the big-boll group by selection or by crossing combined with selection, and in habit of growth, size of boll, etc., resemble that group. The majority of the long-staples constitute a uniform division with plants slender rather than stocky in growth; limbs sometimes absent, usually 2 or 3, slender and upright; fruiting branches slender, with short and irregular or long joints; foliage less dense than that of the big-boll group, the leaves small to medium in size with narrower and deeper lobes, softly hairy, later becoming somewhat glabrous, peduncles often very long and slender; bolls small to medium in size, with 3, 4, or 5 locules, each lock of cotton matted into a compact mass; lint weak to moderately strong, very soft, fine, and clinging, the best grades closely resembling Sea Island cotton; seeds medium in size, sometimes partly naked, but usually covered by a brownish gray or gray fuzz. Some of the varieties of this group are claimed to have been developed by crossing Sea Island and Upland cotton. If so, the only distinct trace of their hybrid origin is to be found in the length and fineness of the staple and possibly in the yellow pollen common to many of the varieties. (See Pl. IV, figs. 1 and 2.)

CLUSTER GROUP.

The cluster group is probably a natural division consisting of the derivatives of the old Sugar-Loaf,[a] a variety of cotton cultivated many years ago in Mississippi and said to have been imported from Mexico. The plants are of abnormal growth, with one or more long, heavy limbs, and with fruiting branches so short jointed as to be reduced to spurs not more than 2 or 3 inches long, the leaves and bolls being crowded together in a cluster. Most of the leaves on the fruiting branches are reduced in size, but the stem leaves are very large, with broad and short lobes, thick in texture, almost glabrous; bolls medium in size, usually rounded in shape, with 4 to 5 locks; lint usually rather short, soft, and of good strength; seeds small to medium in size, fuzzy, gray to brownish, or greenish gray. (See Pl. V, figs. 1 and 2.)

The cluster character of this group is modified, but not lost, by cross-breeding with normal cottons, and many varieties in other groups contain an admixture of cluster blood.

SEMICLUSTER GROUP.

Where the admixture of cluster blood is very noticeable and the variety does not belong to any other particular group it is classed as "semicluster," forming at best a hybrid group of cottons. (See Pl. VI, figs. 1 and 2.)

EARLY GROUP.

The short-limb division as proposed by Professor Duggar contains the early varieties and should be known as the early group, since the term "short limb" is often applied in referring to the fruiting branches of the cluster and semicluster cottons. As a correlative character to earliness the fruiting branches are medium to short jointed, but not abnormally so; the plant is slender rather than stocky and rather low in growth; limbs 1 to 3; leaves small to medium in size, softly hairy, becoming somewhat glabrous with age; lobes narrower and deeper than those of big-boll cottons; bolls small to medium in size, 3, 4, or 5 locked; lint very short to medium in length, of good strength; seeds small to medium in size, fuzzy, greenish or brownish gray. This group is composed of King and its derivatives and some other cottons developed in North Carolina and Tennessee. (See Pl. VII, figs. 1 and 2.)

LONG-LIMB GROUP.

The long-limb group was based on the once popular Petit Gulf and related varieties, but these cottons have been superseded by earlier

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[a] The King, or Sugar-Loaf, as now grown in North Carolina belongs to another group.

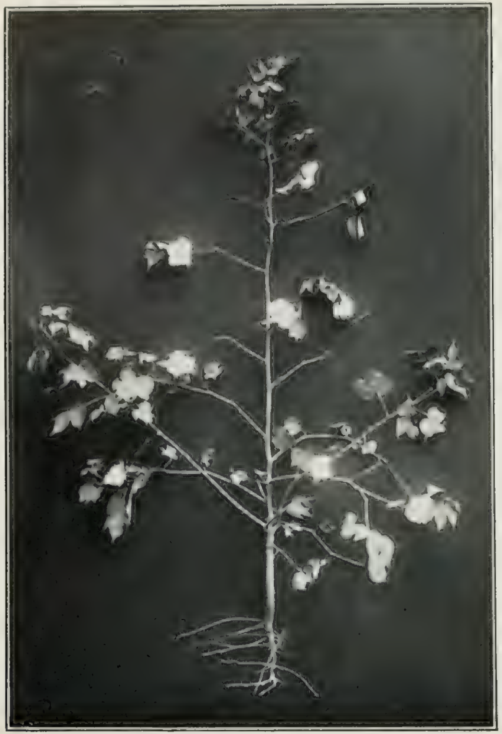

FIG. 1.—PLANT OF THE FLORADORA VARIETY.

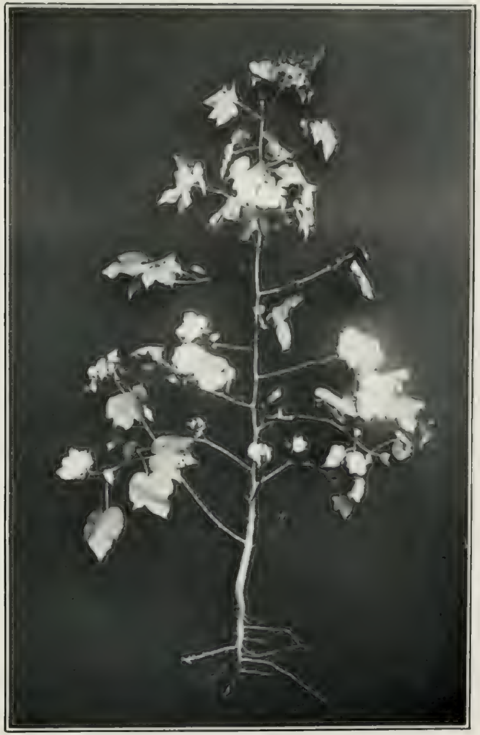

FIG. 2.—PLANT OF THE ALLEN VARIETY.

TYPES OF THE UPLAND LONG-STAPLE GROUP OF COTTON.

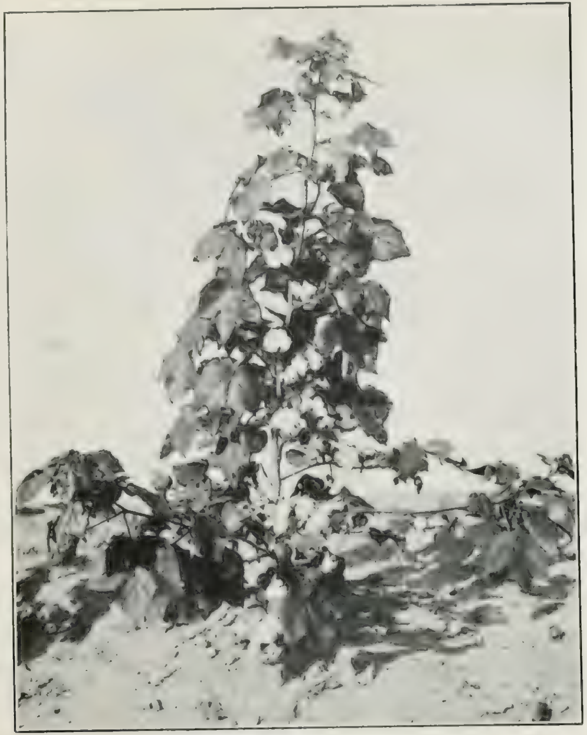

FIG. 1.—PLANT OF THE KELLY VARIETY.

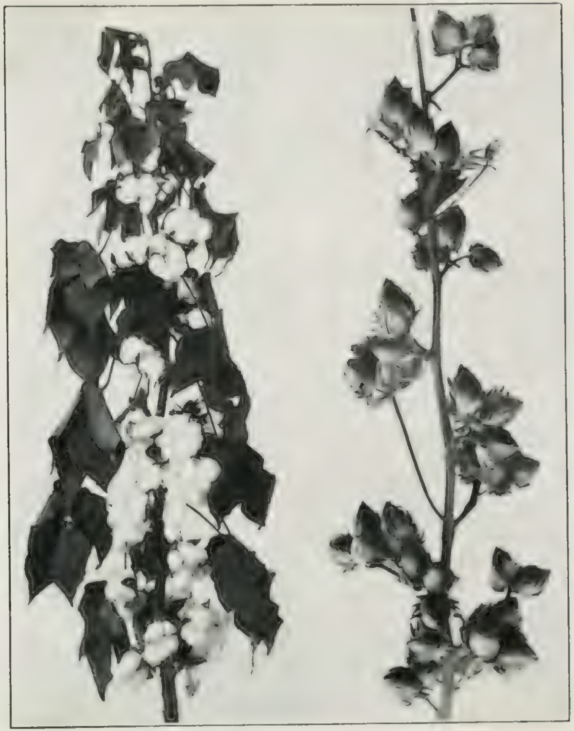

FIG. 2.—PLANT OF THE JACKSON LIMBLESS VARIETY.

TYPES OF THE CLUSTER GROUP OF COTTON.

and more prolific kinds. Although the so-called Petit Gulf is still grown sparingly throughout the South, it is so completely modified by mixing with other varieties that it can not be said to represent the long-limb group.

RIO GRANDE OR PETERKIN GROUP.

The Rio Grande or Peterkin group is a natural division. The plants are slender in growth, with one to several rather light limbs; fruiting branches slender, usually long jointed; leaves small to medium in size, hairy, becoming somewhat glabrous, lobes narrower and deeper than those of the big-boll group; bolls medium to very small in size, with 3, 4, or 5 locules, the locks of cotton remaining rather compact for some time after the boll opens; lint of medium length, of good strength, wiry, and elastic, percentage usually very high; seeds small to very small, some nearly smooth and brownish black, but the majority covered with a short, sparse fuzz. (See Pl. VIII, figs. 1 and 2.)

INTERMEDIATE GROUP.

Most of the named sorts of Upland cotton can easily be referred to their proper group, but some are so badly mixed that they simply form a compound of two or more groups. In time such compounds become intimately blended by cross-fertilization and the resulting cotton can be referred to no particular group, but might well be called nondescript. In Professor Duggar's classification the intermediate group was intended to contain these varieties.

DISCUSSION OF THE GROUPS.

At present the big-boll group is the most widely grown and popular, and its supremacy will probably be permanent unless a successful picking machine is invented. Cottons of this group are more easily and quickly picked than the smaller boll varieties and when conditions permit will be grown in preference to them for that reason alone. In many parts of the cotton belt labor conditions are such that picking is done by the small farmer and his family with very little hired help. On the larger plantations, even when pickers are plentiful, it is often necessary to pay a little more for small-boll picking, and in Texas the difference often amounts to 25 cents per hundred pounds—a strong argument in favor of large-boll cottons. The qualities which make the small-boll varieties specially desirable in some localities, such as earliness, high percentage of lint, and poor-land qualities, have also been developed in the big-boll group, but to a less extent, while the valuable stormproof qualities are peculiar to the derivatives of this group, forming the subdivision called the stormproof group.

Breeders of this group of cottons have attempted, with partial success, to eliminate the four-locked bolls, both because bolls with five locks are larger and because the additional segment of the bur aids in supporting the cotton after the boll opens, making it less liable to be blown out. It is generally known that bolls containing five locks are somewhat larger than those with only four, and in order to determine the exact difference measurements were made of ten different varieties grown by the Department of Agriculture at Waco, Tex., and it was found that a five-locked boll is almost exactly five-fourths the size of one with four locks. The following table gives the results of the measurements:

TABLE II.—*Results of measurements of the bolls of several varieties of cotton having 3, 4, and 5 locks, showing the number of locks to the pound.*

Variety.	5-locked bolls per pound.	4-locked bolls per pound.	3-locked bolls per pound.	5-locked bolls. Locks per pound.	4-locked bolls. Locks per pound.	3-locked bolls. Locks per pound.
	Number.	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*
Bohemian	53	66	....	265	264	....
Culpepper	66	76	....	330	304	....
Davis	55	69	....	275	276	....
Gibson	53	72	....	265	288	....
King	88	94	149	440	376	447
Nicholson	50	66	....	250	264	....
Rowden	53	64	....	265	256	....
Russell	66	76	....	330	304	....
Texas Stormproof	53	76	....	265	304	....
Triumph	47	64	....	235	256	....
Average	58.4	72.3	....	292.0	289.2	....

Varieties of the long-staple group require good soil and culture, great care in ginning and handling the crop, and an appreciative market, but when these conditions are fully met they become very popular and usually prove more profitable than short-staples. Their yield is often considerably lower than that of the latter cottons, but the greater value of the lint is usually enough to more than cover the deficient yield. At the Georgia experiment station, where soil and culture are fairly suitable to long-staples, the results of the variety tests are tabulated in such a way that the premium necessary to make the long-staples equal the best short-staple in the test can be readily determined. In 1906 this premium was 5.6 cents per pound, in 1904 4.68 cents per pound, and in 1902 only 2.2 cents per pound.

The cluster and semicluster cottons are very successful on bottom lands where ordinary varieties are apt to become too "weedy" in growth and partially sterile. On the other hand, the cotton is more difficult to pick clean of trash, and the Dickson and its derivatives are generally considered more liable to the attacks of anthracnose, or boll-rot, and of the bollworm.

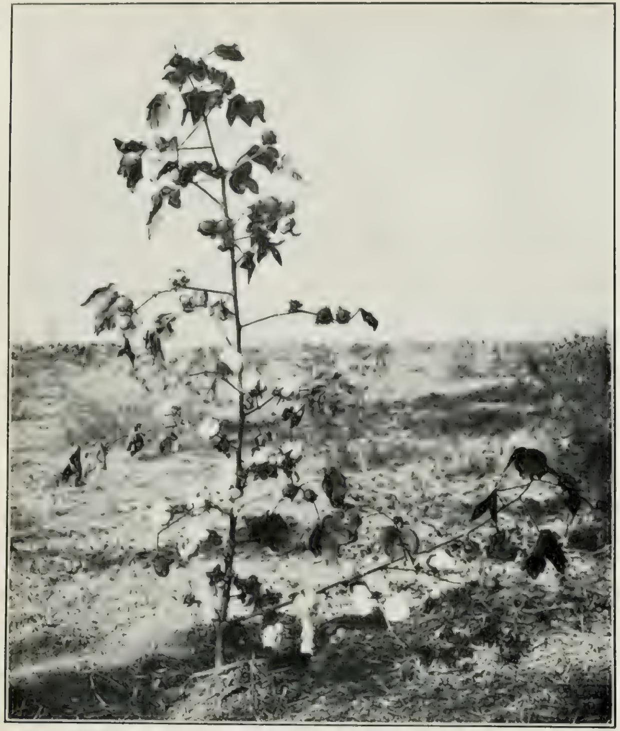

FIG. 1.—PLANT OF THE HAWKINS VARIETY.

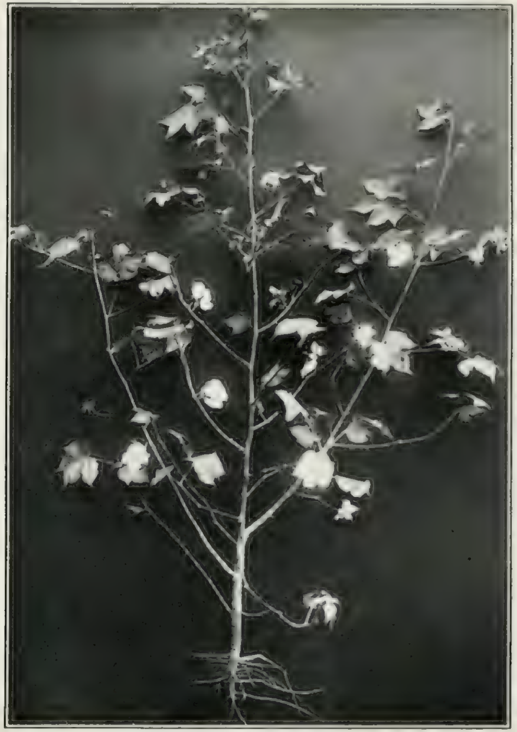

FIG. 2.—PLANT OF THE BOYD PROLIFIC VARIETY.

TYPES OF THE SEMICLUSTER GROUP OF COTTON.

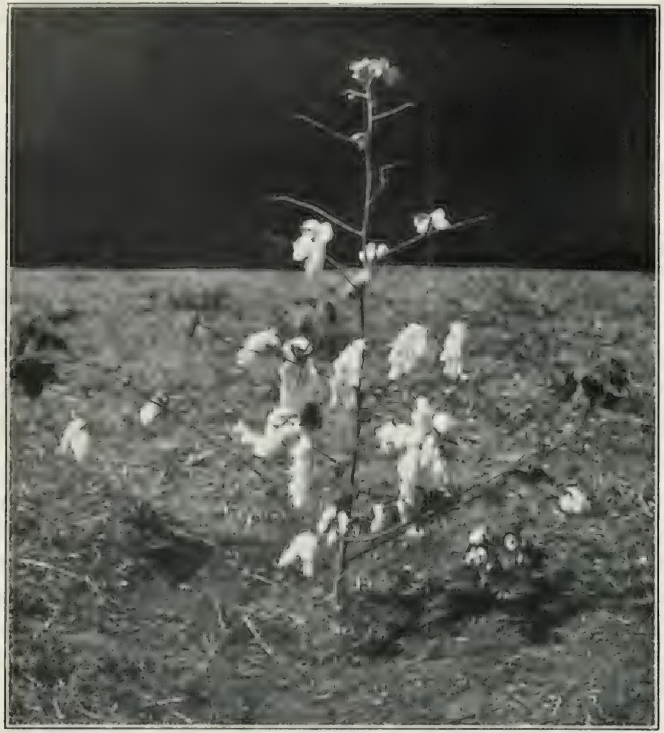

FIG. 1. PLANT OF THE SHINE VARIETY.

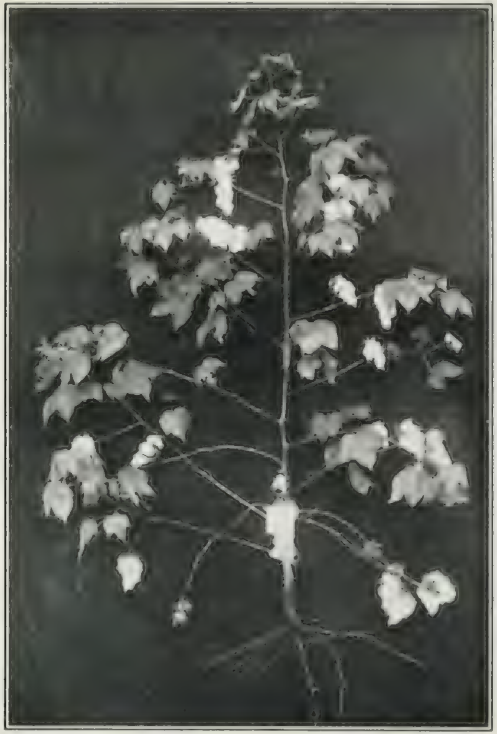

FIG. 2. PLANT OF THE TENNESSEE GREEN-SEED VARIETY.

TYPES OF THE EARLY GROUP OF COTTON.

The early cottons are essential to North Carolina and Tennessee and the upper portions of Georgia and Alabama. They have also been grown successfully in the weevil-infested parts of Texas and Louisiana, but on account of small bolls and lack of stormproof characters are being discarded in favor of the earlier varieties of the stormproof cottons which have recently been developed in Texas.

Cottons of the Peterkin group are among the highest in yield of lint, and aside from this important quality are considered especially adapted to poor land and hard treatment. They are capable, however, of making very large yields under the best conditions. The bolls are small and tedious to pick.

SOURCES OF INFORMATION.

DISTRIBUTION.

To obtain the information regarding the distribution of Upland varieties several thousand inquiries were sent during the spring of 1907 to county and township correspondents throughout the cotton belt. The inquiry was in the form of a printed list of over one hundred names, including all the well-known and standard varieties, and correspondents were asked to check off those in cultivation in their county and to add names of new or local varieties not on the list. In compiling the information so obtained a variety was recorded as occurring in each county from which it was reported regardless of the number of correspondents reporting it from that county, or, in other words, the county was taken as a unit. The distribution of the more widely grown varieties is shown geographically by means of maps, but for the purpose of greater accuracy the more local varieties are listed by counties and States.

MAPS.

The maps of the southeastern portion of the United States include all the area where cotton is cultivated commercially in this country except a small portion of southeastern Virginia. The distribution of each variety of cotton is indicated on the appropriate map by black dots, one dot representing each county from which the variety was reported in 1907.

DESCRIPTIONS.

The descriptions which follow are partly based upon the growth and behavior of the varieties tested by the Department of Agriculture in tests carried on in Terrell, Waco, and Denison, Tex., and in Timmonsville, S. C. Many of the plats used for variety tests conducted by state agricultural experiment stations were visited and studied. As before stated, the behavior of varieties in a test depends upon their suitability to the particular conditions of the test rather more than upon any inherent qualities of superiority or inferiority in the variety, and for this reason as many as possible of the important varieties were also studied on the farms of the originators and the method employed in developing each variety was investigated.

MEASUREMENTS.

Unless otherwise stated the measurements of bolls, lint, and seed which follow the descriptions were made from average samples obtained from the originators of the different varieties during the fall of 1907.

DESCRIPTIONS OF VARIETIES.

Aclin's Easy. EARLY GROUP.

Arkansas: White County.

Developed by E. S. Aclin, Beebe, White County, Ark. Boll of medium size, cotton very easy to pick, seeds white.

Acme, or Allen Acme. LONG-STAPLE GROUP.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture. Louisiana Bulletin 28.

Not now grown.

Adams. EARLY GROUP.

Georgia: Haralson County.

North Carolina: Gaston County.

South Carolina: York County.

Originated by E. H. Adams, Bowling Green, R. F. D. No. 1, S. C. It is a selection from King, made about 1902, and is later in maturity and yields larger bolls and longer lint than the parent variety. Seeds rather large, fuzzy, brownish gray.

Bolls per pound, 60; seeds per pound, 3,460; length of lint, 24.6 mm. ($\frac{31}{32}$ inch), varying from 23 to 27 mm.; strength of single fibers, 6 gms.; per cent of lint to seed, 35.

Adams Long-Staple. UPLAND LONG-STAPLE GROUP.

Mississippi: Adams County.

Originated by C. A. Adams, Arnot, Miss. This is said by Mr. Adams to be an early, long-staple cotton. Bolls medium to small in size, lint fine and silky, of very good length, but low in percentage; seeds fuzzy, gray.

Bolls per pound, 82; seeds per pound, 3,650; length of lint, 34.8 mm. (1$\frac{3}{8}$ inches), varying from 33 to 37 mm.; strength of single fibers, 5.2 gms.; per cent of lint, 26.3.

Adcock. PETERKIN GROUP.

See Barnes.

Adkin. LONG-STAPLE GROUP.

See Keno.

African, or African Long-Limb. BIG-BOLL GROUP.

(Also known as African Towhead.)

Arkansas: Ashley, Faulkner, Howard, and Jefferson counties.

Louisiana: Catahoula, Franklin, Richland, and Union parishes.

Mississippi: Coahoma and Webster counties.

Alabama Bulletin 107. Louisiana Bulletin 16.

This variety is said to have been originated in Ouachita Parish, La., by a negro named Carter Johnson. In Howard County, Ark., it is said to have become a "staple" cotton, yielding lint 1¼ inches in length.

Foliage large and heavy; bolls large, holding the cotton well during storms; seeds large; per cent of lint, 30; length of lint above the average. Not tested.

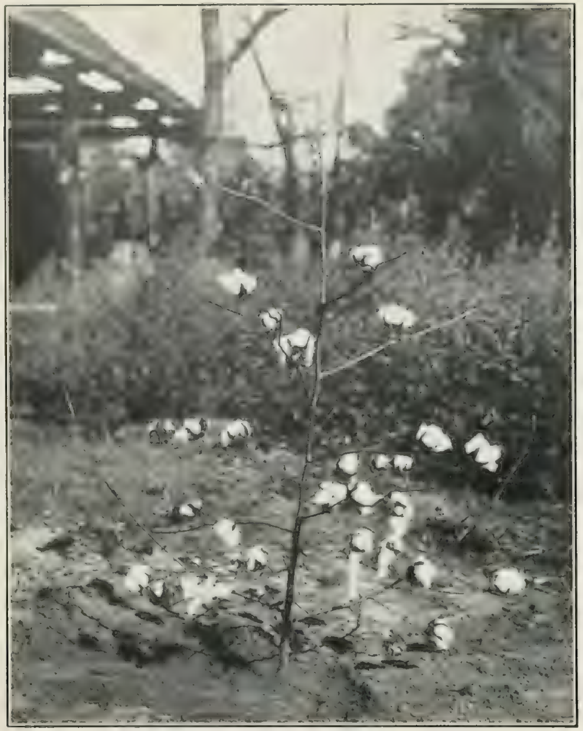

FIG. 1.—PLANT OF THE PETERKIN VARIETY.

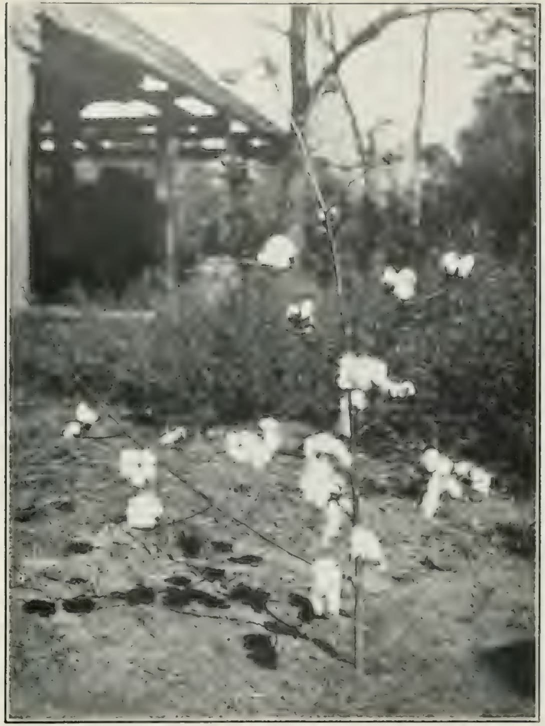

FIG. 2.—PLANT OF THE BERRYHILL VARIETY.

TYPES OF THE PETERKIN GROUP OF COTTON.

African Limbless. Cluster Group.

See Jackson Limbless.

African Queen. Big-Boll Stormproof Group.

Texas: Bosque, Erath, Jones, McLennan, and Stephens counties.

See Rowden.

Aldridge, or Okra. Cluster Group.

Farmer's Dictionary, 1846, page 194.

Not now grown.

Alexander's Okra-Leaf.

North Carolina Bulletin 146.

Not now grown.

Allen Big-Boll, or Alex. Allen. Big-Boll Group.

(Also known as Alex. Allen Big-Boll Prolific and Alex. Allen Improved.)

Distribution: See map, figure 1.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 59, 63, 70.

Originated about 1897 by Alex. W. Allen, Temple, Carroll County, Ga. Plants lacking in uniformity, many of the semicluster habit of growth, with short and irregularly jointed fruiting branches, others of more open growth with longer joints, medium early in maturity. Bolls from small to very large in size; lint of medium length; seeds rather large, fuzzy, brownish or greenish gray. When tested in Texas, this variety proved to be very poor in storm-resistant qualities.

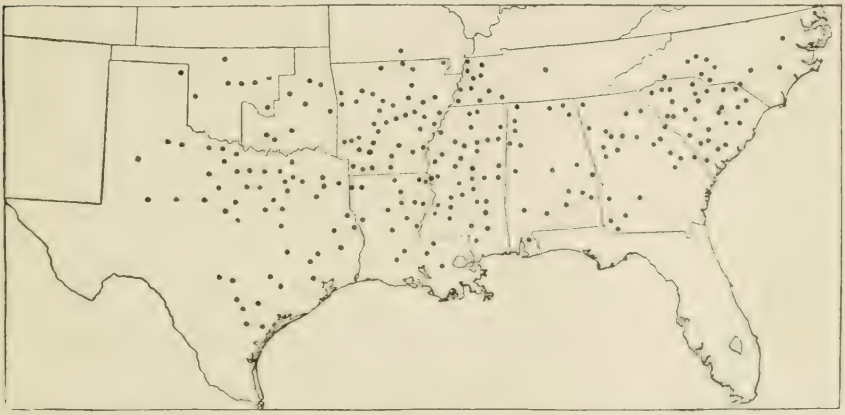

Fig. 1.—Map of the cotton-growing States, showing the distribution of Allen Big-Boll, or Alex. Allen, cotton in cultivation, as reported in 1907.

Selected bolls per pound, 51½; seeds per pound, 3,120; length of lint, 23.5 mm. ($\frac{15}{16}$ inch), varying from 22 to 25 mm.; strength of single fibers, 7.7 gms.; per cent of lint, 34.1.

Allen Improved. Early Group.

Texas: Gray County.

A synonym of King, or Sugar-Loaf.

Allen Long-Staple. Upland Long-Staple Group.

(Also known as Allen Improved.)

Distribution: See map, figure 2.

Alabama Bulletins 12, 13, 16, 33, 40, 56, 76, 89, 101, 107, 130, 140. Arkansas Bulletins 18, 58; First and Third Annual Reports. Georgia Bulletins 11, 20, 39, 43, Louisiana Bulletins 13, 21, 22, 26, 27, old series; 7, 8, 16, 17, 19, 21, 22, 28, 29, 35, 47, 62, 71, new series; Third and Fourth Annual Reports. Mississippi Bulletins 18, 23, 62-83, 84, 87, 88, 98; Second, Third, Fourth, Sixth, Eighth, Twelfth, Thirteenth, and Seventeenth Annual Reports. North Carolina Bulletin 146. South Carolina Bulletins 1, old series; 2, 42, 120, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50, 75. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture. Congressional Cotton Seed Distribution Leaflet for 1903.

A standard variety developed about 1898 by J. B. Allen, Port Gibson, Miss., from earlier varieties since discarded. It has been sold under the names Allen Silk, Allen Long-Staple, Allen Hybrid, J. B. Allen Long-Staple, and Talbot.

Plants tall and pyramidal in shape, uniformly semicluster in habit of growth, with 1 to 3 long limbs from near the base of the stalk, and short, irregularly jointed fruiting branches. This semicluster habit has become more pronounced in the last few years. Bolls medium to small; lint very long and silky; seeds medium to small in size, fuzzy, white.

Bolls per pound, 78; seeds per pound, 3,800; average length of lint, 37 mm. ($1\frac{15}{32}$ inches), varying from 35 to 39 mm.; average strength of single fibers, 4.3 gms.; per cent of lint, 23.3.

Sample from Clarksville, Tex. Bolls per pound, 98; seeds per pound, 4,840; average length of lint, 32.3 mm. ($1\frac{9}{32}$ inches), varying from 30 to 35 mm.; average strength of single fibers, 4.3 gms.; per cent of lint, 29.

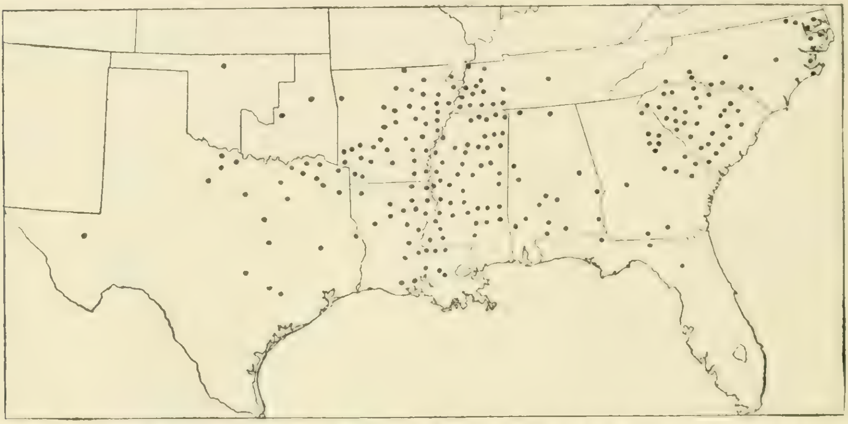

FIG. 2.—Map of the cotton-growing States, showing the distribution of Allen Long-Staple cotton in cultivation, as reported in 1907.

Allen's Red Rustproof.

See Willet Red-Leaf.

Allen's Yellow-Bloom. LONG-STAPLE GROUP.

Congressional Cotton Seed Distribution Leaflet for 1903.

Not now grown. It is said to be one of the parents of Allen's Improved.

Allred's Pet, or Alrid. PETERKIN GROUP.

Mississippi: Claiborne County.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety still grown locally in Mississippi and said to have been developed by a Mr. Allred, of Martin, Claiborne County, Miss.

Alvarado. PETERKIN GROUP.

Georgia: Butts County.

Georgia Bulletin 16. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety introduced into Georgia about 1848, now badly mixed with other sorts.

Amerson. BIG-BOLL GROUP.

Georgia: Johnson, Glasscock, and Laurens counties.

A local variety, early in maturity and yielding fairly large bolls. The originator is unknown.

Anderson. BIG-BOLL GROUP.

Alabama: Winston County.

Georgia: Coweta, Hall, Jackson, Madison, Pike, and Walker counties.

Mississippi: Calhoun County.

Tennessee: Morgan County.

Texas: Shelby County.

Alabama Bulletin 140. Georgia Bulletin 70.

Originated by J. W. Anderson, Williamson, Pike County, Ga. A semicluster, large-bolled variety, plants short and stocky in growth, fruiting branches short and irregularly jointed; bolls very large; lint of medium length, low in percentage; seeds very large, fuzzy, gray and greenish gray.

Bolls per pound, 46; seeds per pound, 2,820; average length of lint, 24.4 mm. ($\frac{15}{16}$ inch), varying from 22 to 26 mm.; strength of single fibers, 5.7 gms.; per cent of lint, 29.1.

Angora.

A local variety grown in Dallas County, Ala.

Anson Cream. PETERKIN GROUP.

Alabama Bulletin 140. Georgia Bulletin 43. North Carolina Bulletin 168.

Formerly grown in Anson County, N. C.

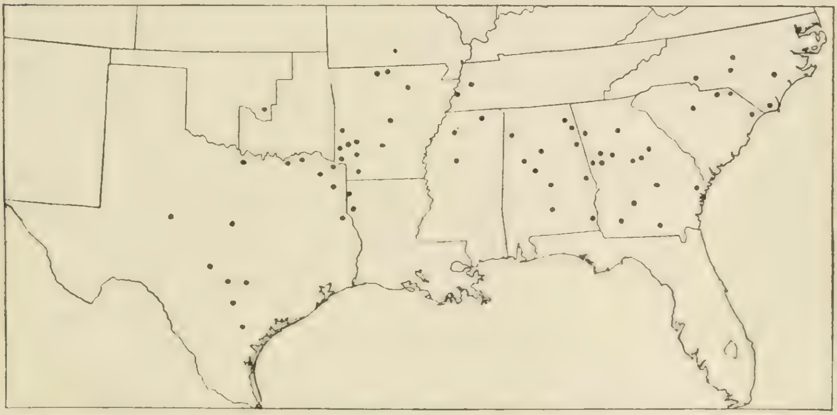

FIG. 3.—Map of the cotton-growing States, showing the distribution of Bagley's Big-Boll cotton in cultivation, as reported in 1907.

Apple-Boll. BIG-BOLL STORMPROOF GROUP.

Texas: Dallas and Van Zandt counties.

See Jackson Round-Boll.

Arkansas Wonder. EARLY GROUP.

Tested by the Alabama Agricultural Experiment Station, Auburn, Ala., in 1907. Plant compact in growth, limbs 1 to 3, fruiting branches rather long but short jointed, some plants showing a strong tendency toward the semicluster habit; bolls small to medium in size, blunt and rounded in shape; lint of medium length; seeds of medium size, fuzzy, gray or greenish gray.

Bolls per pound, 79½; seeds per pound, 3,940; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 22 to 26 mm.; per cent of lint, 32.3.

Audrey Peterkin. PETERKIN GROUP.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A strain of Peterkin not now grown.

Aurton, or Auraton. UPLAND LONG-STAPLE GROUP.

A local variety grown quite extensively near Chotard, Issaquena County, Miss. Originator unknown. Not tested.

Bachelor.

A synonym of Drake Defiance.

Baggett's Improved. BIG-BOLL GROUP.

Alabama: Conecuh County.

Developed by J. A. T. Baggett, Castleberry, Ala., by selection from Texas Stormproof cotton.

Bolls medium to large; seeds large, fuzzy ,brownish gray.

Bolls per pound, 64; seeds per pound, 3,450; average length of lint, 22.7 mm. ($\frac{29}{32}$ inch), varying from 21 to 25 mm.; strength of single fibers, 5.6 gms.; per cent of lint, 34.3.

Bagley's Big-Boll. BIG-BOLL GROUP.

Distribution: See map, figure 3.

In the Eastern States this is a corruption of the name "Beggarly's Big-Boll." It has become confused with a cotton said to have been originated by Ed. Bagley, Ashdown, Little River County, Ark. Not tested.

Bahama. BIG-BOLL STORMPROOF GROUP.

South Carolina First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Said to be the same as Texas Stormproof. Not now grown.

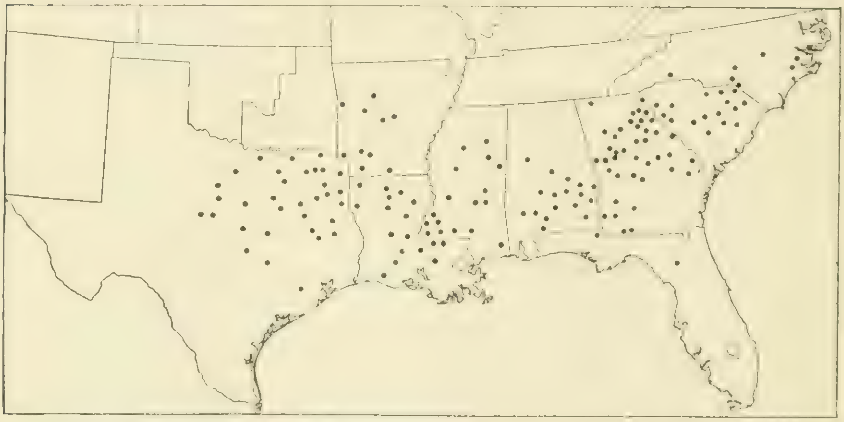

FIG. 4.—Map of the cotton-growing States, showing the distribution of Bancroft's Herlong cotton in cultivation, as reported in 1907.

Bailey. UPLAND LONG-STAPLE GROUP.

Alabama Bulletins 13, 33, 40, 56, 107, 140. Mississippi Bulletins 18, 62; Fourth and Eighth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Introduced by T. J. King, Louisburg, N. C., and the Bailey Cotton Company, Raleigh, N. C. Not now grown.

The lint is said to have measured from 28 to 30 mm. in length; per cent of lint, 25 to 30.

Baldwin's All-Around. BIG-BOLL GROUP.

Georgia: Morgan and Putnam counties.

A local variety developed by C. S. Baldwin, Madison, Morgan County, Ga., by selection from Nancy Hanks.

Bolls per pound, 51½; seeds per pound, 3,315; average length of lint, 22.6 mm. ($\frac{29}{32}$ inch), varying from 21 to 24 mm.; strength of single fibers, 5.6 gms.; per cent of lint, 34.1; seeds fuzzy, gray.

Ballard.

A local variety formerly grown in Marion County, Ala.

Banana. CLUSTER GROUP.

Reports of the Patent Office for 1848 and 1850. Report of the Commissioner of Agriculture for 1866. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety grown over fifty years ago and long since discarded.

Bancroft Prolific Long-Staple. UPLAND LONG-STAPLE GROUP.

Louisiana Bulletin 21. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Origin unknown. Not now in cultivation.

Bancroft's Herlong. BIG-BOLL GROUP.

(Also known as Bancroft's Prolific and Bancroft's Improved.)

Distribution: See map, figure 4.

Alabama Bulletins 33, 34, 40, 52, 56, 76, 107, 130, 140. Arkansas Bulletin 18. Georgia Bulletins 11, 20, 56, 63, 66. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 7, 8, 16, 21, 22, 28, 35, 47, new series. Mississippi Bulletins 18, 23, 98; Second, Third, Fourth, and Sixth Annual Reports. South Carolina Bulletins 1, old series; 2, 18, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

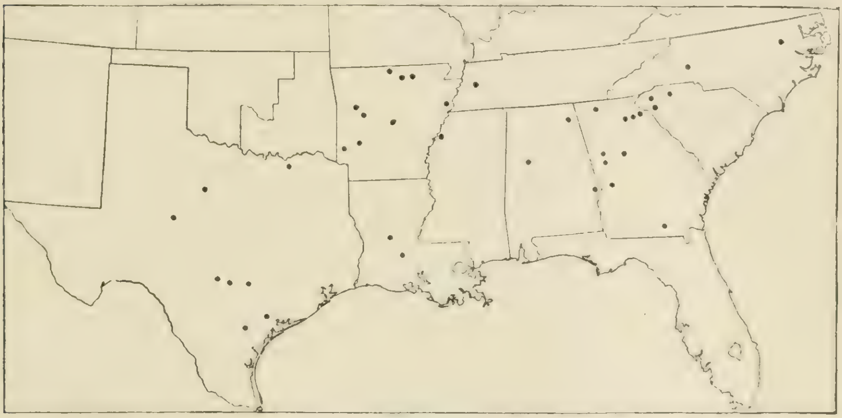

FIG. 5.—Map of the cotton-growing States, showing the distribution of Banks's Big-Boll cotton in cultivation, as reported in 1907.

A large-bolled, green-seeded cotton developed by Edward Bancroft, of Athens, Ga. Mr. Bancroft states that in 1868 a man named Herlong, living in Alabama, sent about a dozen cotton seeds in a letter to Dr. W. L. Jones, then editor of the Southern Cultivator, who gave them to Mr. Bancroft to try. At first the variety was too late in maturing and it was then mixed with an earlier cotton, probably Dickson, to which is due the mixture of white seed and semicluster habit. The bolls were formerly smaller; in 1888, 100 bolls weighed a pound; in 1891, 93; and in 1902, 75.

Plants not uniform in growth, the majority semiclustered, others open and long branched; leaves large; bolls large, about 50 per cent 5 locked; seeds large, fuzzy, green and brown in color. This is said by Prof. J. F. Duggar to be practically identical with Russell, and it is true that plants of the long-branched type are quite similar to Russell, but the variety as a whole is too nearly a semicluster type to be considered identical.

Bolls per pound, 61; seeds per pound, 3,310; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.9 gms.; per cent of lint, 34.

Banks's Big-Boll. BIG-BOLL GROUP.

Distribution: See map, figure 5.

Alabama Bulletins 107, 140. Georgia Bulletin 43.

This variety is a descendant of Wyche. W. H. Banks, of Newnan, Coweta County, Ga., states that he obtained the seed many years ago from Warren Beggarly, of Senoia, the introducer of Wyche cotton.

Plant very similar to Wyche, large and stocky in growth; leaves large, fruiting branches usually long jointed, but some plants showing a trace of semicluster type and having shorter and irregularly jointed fruiting branches; bolls very large; lint of good length; seeds very large, fuzzy, gray.

Bolls per pound, 44; seeds per pound, 2,590; average length of lint, 25.5 mm. (1 inch), varying from 23 to 29 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 34.2.

Banny Brown. BIG-BOLL STORMPROOF GROUP.

Arkansas: Drew County.

A local variety developed, about 1897, by selection, by Banny Brown, of Lacey, Ark.

Barfield. CLUSTER GROUP.

A local variety reported only from Kemper County, Miss., and Anson County, N. C.

This cotton was introduced by Thomas Barfield, of Sucarnoochee, Miss., many years ago, and it is said that he obtained the seed in the West Indies. It was taken to Cedarhill, N. C., by Dr. S. B. Carpenter, who has kept the seed pure. Barfield has become a popular variety in Anson County, being "especially suited to the loamy clay soil of the Piedmont section."

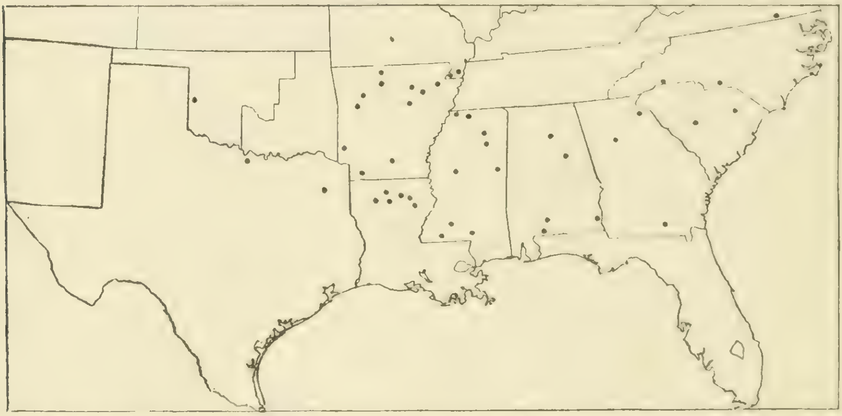

FIG. 6.—Map of the cotton-growing States, showing the distribution of Bass cotton in cultivation, as reported in 1907.

The plant is a true cluster cotton, with 1 or 2 long limbs and with fruiting branches reduced to mere spurs; bolls of medium size, closely clustered together; seeds small, fuzzy, white; per cent of lint, about 35.

In Mississippi the Barfield has become a "bender" cotton, but in North Carolina the lint is of medium length.

Barnes. PETERKIN GROUP.

(Also known as Adcock.)

Alabama Bulletin 140. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Reported only from Leake County, Miss., and said to be the same as Adcock, a local variety grown in the same county. Bolls of good size, cotton easy to pick and wasting badly during storms; lint about three-fourths inch long, per cent, 38.4; seeds small, fuzzy, gray. Not tested.

Barnett, or Barnett Short-Staple. SEMICLUSTER GROUP.

Alabama Bulletins 5, 12, 13, 16, 33, 56, 107, 140. Alabama (Canebrake) Bulletins 7, 11, 14. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety not now in cultivation. Originator unknown.

Barrett. UPLAND LONG-STAPLE GROUP.

Georgia: Wilkes County.

Developed from a Mississippi cotton by W. G. Barrett, Royal, Ga. Not tested.

Basefield.

Reported only from Rusk County, Tex. Originator said to be a Mr. Basefield, of Minden, Tex. Not tested.

Bass. SEMICLUSTER GROUP.

(Also known as Bass Cluster and Bass Big-Boll.)

Distribution: See map, figure 6.

Originator said to be I. Bass, of Columbia, Marion County, Miss. Not a uniform variety; plants both semicluster and open in growth, the majority semicluster; bolls medium to large in size; lint of good length; seeds small, fuzzy, greenish or brownish gray.

Bolls per pound, 88; seeds per pound, 5,050; average length of lint, 25.5 mm. (1 inch); average strength of single fibers, 6 gms.; per cent of lint, 30.

Bates Big-Boll. BIG-BOLL GROUP.

Alabama Bulletin 89. Georgia Bulletin 20. Mississippi Bulletin 62; Sixth and Eighth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Developed some years ago by R. Bates, of Jackson, S. C. Not now grown.

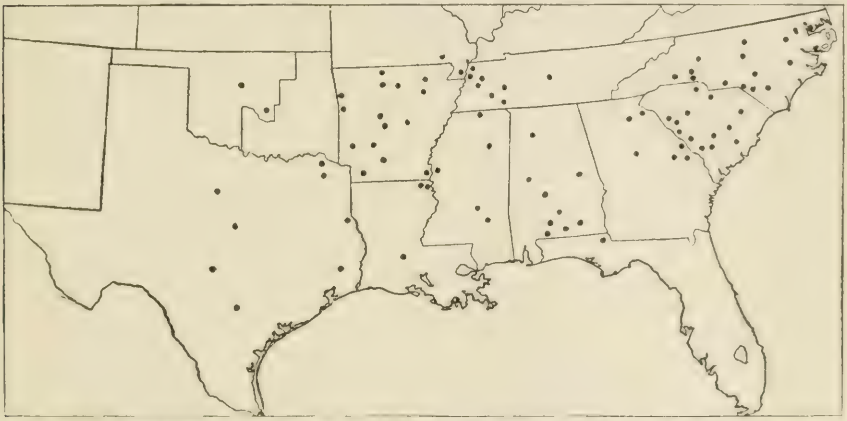

FIG. 7.—Map of the cotton-growing States, showing the distribution of Bates Little Brown-Seed cotton in cultivation, as reported in 1907.

Bates Favorite. PETERKIN GROUP.

Georgia Bulletin 24. Mississippi Bulletin 62; Sixth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety not now cultivated. It was developed by R. Bates, Jackson, S. C., and was very similar to Bates Poor-Land.

Bates Improved Prolific. PETERKIN GROUP.

Georgia Bulletins 27, 31. South Carolina Bulletins 42, 120. "Cotton," vol. 11, no. 5.

Developed by R. Bates, Jackson, S. C., and similar to Bates Poor-Land. Not now cultivated.

Bates Little Brown-Seed. PETERKIN GROUP.

Distribution: See map, figure 7.

Alabama Bulletin 140. Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports.

Developed by R. Bates, Jackson, S. C., and very similar to Bates Victor. Bolls per pound, 119; seeds per pound, 6,480; average length of lint, 21.6 mm. (⅞ inch), varying from 20 to 23 mm.; strength of single fibers, 5.5 gms.; per cent of lint, 41.9.

Bates Poor-Land. PETERKIN GROUP.

Distribution: See map, figure 8.

Alabama Bulletins 107, 140.

Developed by R. Bates, Jackson, S. C., and very similar to Bates Victor.

Bates Victor. PETERKIN GROUP.

Developed by R. Bates, Jackson, S. C., by selection from Bates Poor-Land cotton, which descended from Bates Little Brown-Seed.

The Brown-Seed variety was derived from the old Rio Grande cotton mixed with a variety known as Australian Brown-Seed. The older varieties have been discarded in favor of the latest improvement.

Plants uniform in habit of growth, very similar to Peterkin, with 1 to 3 rather slender limbs and numerous slender fruiting branches; bolls small in size; lint short, rather harsh, wiry, and elastic, percentage very high; seeds very small, covered with a short, brownish gray fuzz, none naked.

Bolls per pound, 113; seeds per pound, 6,235; average length of lint, 23.4 mm. ($\frac{29}{32}$ inch), varying from 22 to 26 mm.; strength of single fibers, 5.9 gms.; per cent of lint to seed, 40.3.

Beard. BIG-BOLL GROUP.

Texas: Wise County.

A local variety said to have originated in Louisiana. Not tested.

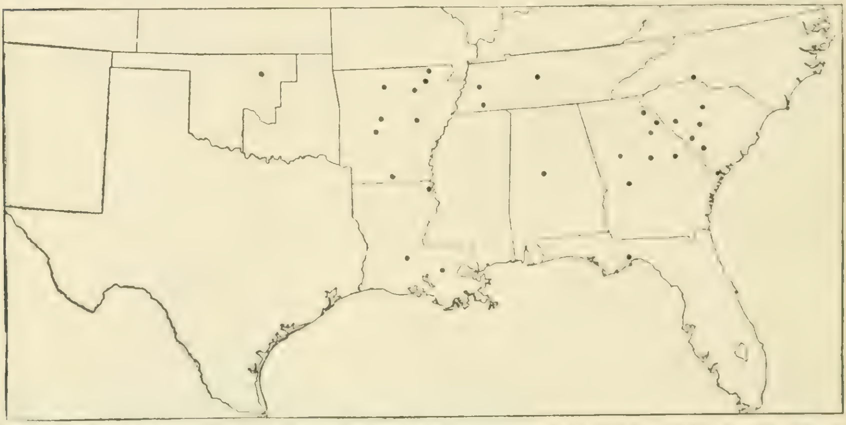

FIG. 8.—Map of the cotton-growing States, showing the distribution of Bates Poor-Land cotton in cultivation, as reported in 1907.

Beat-All, or Hart's Improved. BIG-BOLL GROUP.

Georgia: Bibb, Chattahooche, Grady, Jefferson, Lee, Schley, Talbot, Terrell, Webster, Wilcox, and Worth counties.

Georgia Bulletins 75, 79.

Originated about fifty years ago by Calvin Carter and Isaac Hart, of Ellaville, Schley County, Ga., and has been grown on the same farm and kept pure until the present time by Emmet Hart, a son of one of the originators. Beat-All is a remarkably uniform variety and for many years has been very popular locally in southern Georgia. It was tested in 1906 and 1907 by the Georgia Experiment Station under the name "Hart's Improved." The results of these tests show that Beat-All is unsuited to the rich soil of the station, as it stood twenty-fourth and twenty-sixth in productiveness. It is usually considered specially suited to poor and worn-out land.

Plant large and stocky in growth, late in maturity, limbs 2 to 3, heavy; fruiting branches long and rather long jointed; bolls large; lint of medium length, percentage good; seeds large, fuzzy, brownish gray.

Bolls per pound, 51½; seeds per pound, 3,430; average length of lint, 25.4 mm. (1 inch), varying from 24 to 28 mm.; average strength of single fibers, 6.9 gms.; per cent of lint, 35.7.

Beatty. BIG-BOLL GROUP.

A variety tested by the Louisiana Experiment Station, Baton Rouge, La., in 1907.

Bolls per pound, 60; seeds per pound, 3,630; average length of lint, 24.5 mm. ($\frac{31}{32}$ inch), varying from 23 to 27 mm.; per cent of lint, 31.9.

Becks Big-Boll. BIG-BOLL GROUP.

(Also known as Becks Prolific and Becks Improved.)

Texas Bulletins 34, 40, 45, 50.

A local variety formerly grown in Texas.

Beggarly Big-Boll.

See Wyche.

Belle Creole. UPLAND LONG-STAPLE GROUP.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

The ancestor of Jethro, Jones Long-Staple, Six Oaks, and others. An old variety, grown about seventy-five years ago.

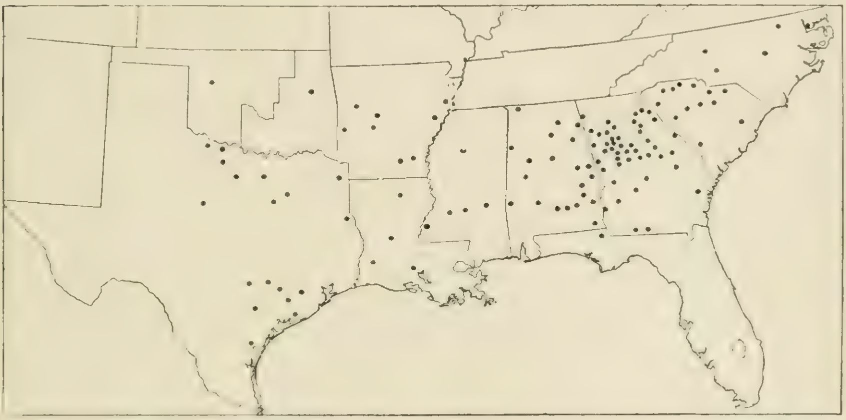

FIG. 9.—Map of the cotton-growing States, showing the distribution of Berry cotton in cultivation, as reported in 1907.

Benders.

Not a varietal name. It is applied on the New Orleans market to a medium long-staple cotton coming from the bends of the Mississippi River in Louisiana, Mississippi, and Arkansas. The staple usually averages 1¼ inches long and is also called "quarter" cotton.

Berry. BIG-BOLL GROUP.

(Also known as Berry's Early Big-Boll.)

Distribution: See map, figure 9.

Alabama Bulletins 138, 140. Alabama (Tuskegee) Bulletin 7. Alabama (Canebrake) Bulletin 23. Georgia Bulletins 52, 59. Mississippi Bulletin 88.

J. L. Berry, of Griffin, Ga., developed this variety from a stray plant found growing in his yard in 1895. It differs from other closely related big-bolls in its semicluster habit of growth and early maturity.

Plants usually semicluster in growth, with 1 to 3 long limbs and numerous short and irregularly jointed fruiting branches; a few plants more open in growth, with longer fruiting branches; bolls large, lint of good length, rather low in percentage; seeds large, fuzzy, gray or greenish gray in color.

The following measurements were taken from a representative sample obtained from Mr. Berry's farm at Griffin.

Bolls per pound, 50; seeds per pound, 2,840; average length of lint, 25.6 mm. ($1\frac{1}{32}$ inches), varying from 23 to 28 mm.; average strength of single fibers, 6 gms.; per cent of lint to seed, 30. Unfortunately, this variety does not make as good a showing when tested away from home. At the experiment stations of Alabama, Louisiana, and Texas in 1907 the bolls averaged 60 per pound, the lint averaged 22.5 mm. ($\frac{29}{32}$ inch) in length, and the per cent 29.2.

Berryhill. PETERKIN GROUP.

Georgia: Cobb County.

Mississippi: Amite and Washington counties.

South Carolina: Darlington County.

Texas: Fayette County.

Alabama Bulletin 140. Georgia Bulletin 43.

A variety developed by selection from Brannon, by F. M. Berryhill, of Aline, Miss.

Plants not uniform, both semicluster and long branched in habit; bolls medium in size; percentage of lint good; seeds small, fuzzy, greenish and brownish gray in color.

Bolls per pound, 76; seeds per pound, 5,380; average length of lint, 23 mm. ([illegible] inch), varying from 21 to 24 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 36.8.

Bertrand Improved. SEMICLUSTER GROUP.

A synonym of Hawkins.

Best-Crop. BIG-BOLL GROUP.

Reported only from Cobb County, Ga. Originated by T. Y. Crowder, Kennesaw, Ga.

Plant not seen. Bolls very large, lint of good length, just "thirding itself" in percentage, seeds very large, fuzzy, white.

Bolls per pound, $38\frac{1}{2}$; seeds per pound, 2,550; average length of lint, 26 mm. ($1\frac{1}{32}$ inches), varying from 24 to 27 mm.; average strength of single fibers, 6.8 gms.; per cent of lint to seed, 33.3.

Biard Green-Seed. BIG-BOLL GROUP.

Developed by selection from the old Green-Seed variety by J. R. Biard, Hugo, Okla. A local variety reported only from Choctaw County, Okla. Not tested.

Bidel Hoover.

A local variety reported from Covington County, Ala. Originator unknown. Not tested.

Bienvenu Bender.

A local variety reported from Pointe Coupee Parish, La. Originator unknown. Not tested.

Big-Boll Green-Seed.

See Russell.

Big Brannon. PETERKIN GROUP.

A selection for larger bolls; otherwise similar to Brannon. Tested by the Louisiana Experiment Station, Baton Rouge, La., in 1907. A sample obtained from that station measures as follows:

Bolls per pound, 66; seeds per pound, 4,000; average length of lint, 24.6 mm. ($\frac{31}{32}$ inch), varying from 23 to 26 mm.; per cent of lint to seed, 31.9; seeds fuzzy, greenish or brownish gray or nearly smooth and black.

Big-Buck. BIG-BOLL STORMPROOF GROUP.

A local variety, grown extensively in Collin County, Tex. It is said that the seed was taken to Collin from Liberty County, Tex., several years ago.

Bigham. SEMICLUSTER GROUP.

Originated by L. H. Bigham, of Forrestville, Florence County, S. C., and introduced by him in 1896.

Plants semicluster in habit of growth, but not uniform, there being a considerable proportion of longer branched plants with larger bolls; lint of good length - the percentage, which is claimed to be very high, in our test proved to be only medium; seeds small, fuzzy, brownish gray.

Bolls per pound, $79\frac{1}{2}$; seeds per pound, 4,160; average length of lint, 28 mm. ($1\frac{3}{32}$ inches), varying from 25 to 30 mm.; strength of single fibers, 5.8 gms.; per cent of lint to seed, 32.4.

Biglow. Big-Boll Group.

A local variety, grown in Johnson and Howard counties, Ark. It was introduced about 1882 and has become a popular variety in these counties. Originator unknown. Not tested.

Bigner. Peterkin Group.

A local variety, grown in Lawrence County, Miss., and said to have been originated by L. A. Bigner, of that county. Not tested.

Bishop. Upland Long-Staple Group.

Reported only from Choctaw County, Ala. It is stated that the plant is somewhat clustered in growth, maturing early, bolls small, lint medium to long and percentage rather low. Originator unknown. Not tested.

Blackburn. Big-Boll Group.

A local variety, grown in Fayette County, Ala., and originated by John Blackburn, Fayette, Ala.

Bolls per pound, 52; seeds per pound, 3,690; average length of lint, 24.2 mm. ($\frac{15}{16}$ inch), varying from 23 to 28 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 36.

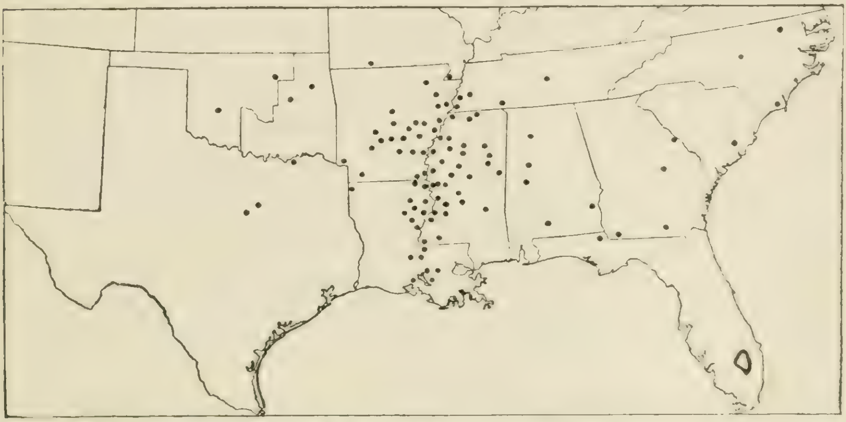

FIG. 10. Map of the cotton-growing States, showing the distribution of Black Rattler cotton in cultivation, as reported in 1907.

Black Peterkin. Peterkin Group.

Reported from Jackson County, Fla. A selection from Peterkin yielding smooth, black seed. Bolls of medium size; lint of medium length, per cent about 39. Not tested.

Black Prolific. Peterkin Group.

Originated by J. P. Black, Adelle, Madison County, Miss., and reported also from Hinds County.

Bolls rather small; seeds small, fuzzy, brownish gray; lint of medium length, percentage a little above the average.

Bolls per pound, 79½; seeds per pound, 5,050; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 22 to 28 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 34.5.

Black Rattler. Upland Long-Staple Group.

Distribution: See map, figure 10.

Alabama Bulletin 140. Mississippi Bulletins 83, 84, 87; Seventeenth Annual Report.

A "quarter" cotton, grown quite extensively near the Mississippi River. It is said to have been developed in Bolivar County, Miss., but the originator's name is not known.

Plants rather large in growth, with 1 to 3 limbs and slender, medium-jointed fruiting branches; leaves medium to small in size; bolls small, pointed, the bur sharp, lacerating the hands of pickers; lint rather short for a long-staple cotton, not as silky as Allen, of fair strength, percentage of lint medium; seeds nearly smooth, black.

Bolls per pound, 94; seeds per pound, 5,670; average length of lint, 31 mm. ($1\frac{7}{32}$ inches); strength of single fibers, 4.8 gms.; per cent of lint to seed, 32.6.

Black Ribbon. UPLAND LONG-STAPLE GROUP.

Alabama Bulletin 130. South Carolina Bulletin 120.

Developed by the South Carolina Agricultural Experiment Station, Clemson College, S. C.

A black-seeded selection from Blue Ribbon; otherwise the same as that variety.

Black-Seed.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A name generally applied to Sea Island cotton, but in some sections to a smooth-seeded strain of Peterkin.

Blanchard Improved.

A local variety formerly grown in Lincoln and Columbia counties, Ga. Not reported lately and probably not in cultivation.

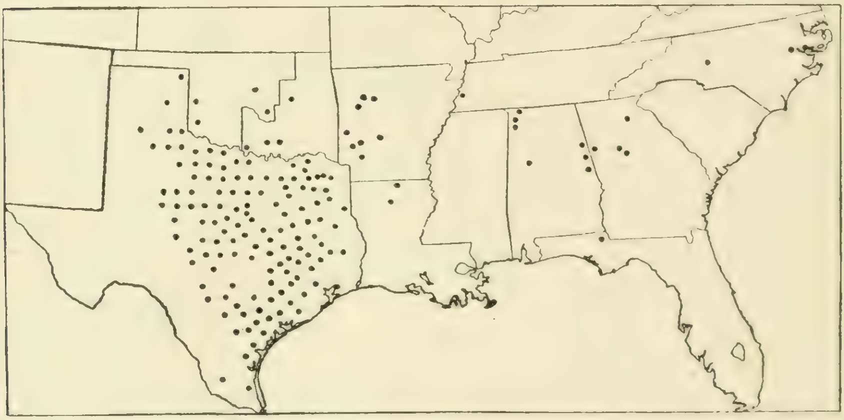

FIG. 11.—Map of the cotton-growing States, showing the distribution of Bohemian cotton in cultivation, as reported in 1907.

Blue Ribbon. UPLAND LONG-STAPLE GROUP.

Alabama Bulletins 130, 138, 140. Georgia Bulletin 59. South Carolina Bulletin 120.

Developed by the South Carolina Agricultural Experiment Station, Clemson College, S. C., and reported as being grown in Greenwood and Lancaster counties, S. C. A cross between Dickson and Allen Long-Staple, semicluster in habit of growth; lint rather short for a long-staple cotton, percentage medium.

Bob, or Bob-Silk.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now in cultivation.

Bohemian. BIG-BOLL STORMPROOF GROUP.

(Also known as Supak, Shupark, Shoepock, Shuparch, etc.)

Distribution: See map, figure 11.

Alabama Bulletin 140. Texas Bulletins 34, 40, 45, 50.

Originated nearly fifty years ago by a Bohemian settler named Supak living in Travis, Austin County, Tex. It has been one of the most popular varieties grown in Texas, and is still grown extensively, though considerably mixed with other cottons. It is the parent of Rowden and some other varieties.

Plant rather large; limbs 2 to 3, stocky, often nearly prostrate; fruiting branches numerous, long, and somewhat drooping; joints short and regular, making the plant very prolific; foliage quite large and heavy, bolls large, the majority 5-locked, usually turned downward by their weight, aided by the drooping branches, so that when the boll opens the cotton is protected by a roof formed partly by the broad backs of the segments of the bur and partly by the large involucres; locks of cotton clinging together and easily picked; lint of medium length; seeds large, fuzzy, gray or brownish gray.

Bolls per pound, 55; seeds per pound, 3,240; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 25 mm.; average strength of single fibers, 5.3 gms.; per cent of lint, 33 to 34.

Bollworm Immune.

A strain of Russell developed by C. A. Towles, Cork, Butts County, Ga., and reported only from that county.

Bolls per pound, 58; seeds per pound, 3,045; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 23 to 25 mm.; strength of single fibers, 6.8 gms; per cent of lint, 33.

Bond's Prolific.

Louisiana Bulletin 71.

Not now grown.

Boozer. UPLAND LONG-STAPLE GROUP.

Alabama: Talladega County.

Arkansas: Faulkner and Lincoln counties.

Georgia: Franklin County.

Mississippi: Perry, Simpson, and Smith counties.

Texas: Bosque, Gregg, Limestone, Red River, and Young counties.

Originated in Red River County, Tex., by W. R. Boozer, and is especially suited to sandy upland soil where other long-staple varieties fail.

Plant tall and pyramidal in shape, with 1 to 3 limbs, and numerous slender fruiting branches, the latter with regular joints of medium length; leaves light green, rather small in size; bolls small, pointed; lint very soft and silky, percentage low; seeds rather small, fuzzy, with sparse gray fuzz.

Bolls per pound, 87; seeds per pound, 4,100; average length of lint, 32 mm. ($1\frac{1}{4}$ inches), varying from 25 to 36 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 27.6.

Borden, or Borden Prolific.

Alabama Bulletins 107, 140. South Carolina Second Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Borneo.

Louisiana Bulletin 62.

Not now grown.

Boyd Prolific. SEMICLUSTER GROUP.

Distribution: See map, figure 12.

Alabama Bulletins 76, 107, 140. Arkansas Third Annual Report. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 7, 8, 16, 17, 22, 28, 47, 62, 71, new series; Third and Fourth Annual Reports. Mississippi Bulletin 18; Fourth Annual Report. Texas Bulletin 40. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety grown in Mississippi sixty years ago and the parent of several improved cottons of to-day. It is said to have been originated by a Mr. Boyd, of Mississippi. Although this variety, so called, is grown over a large portion of the cotton belt, it is so badly mixed as to have lost its identity. The samples tested by us proved to belong to the long-staple Upland group. The true Boyd Prolific is described as being a semicluster cotton, with 1 to 3 limbs and numerous fruiting branches with short and irregular joints; bolls medium to small, rounded; lint rather short, per cent 30 to 32; seeds small, fuzzy, brownish gray.

Boykin Stormproof. BIG-BOLL STORMPROOF GROUP.

Distribution: See map, figure 13.

Originated by W. L. Boykin, Kaufman, Kaufman County, Tex. Plant large and stocky in growth, fruiting branches long and long jointed, rather late in maturity; bolls large to very large, the majority 5-locked, holding the cotton well during storms, but very easily picked, as the bolls hang downward and the locks cling together in one mass; lint of good length, percentage good; seeds large, fuzzy, brownish gray.

Bolls per pound, 50; seeds per pound, 3,280; average length of lint, 26.2 mm. (1$\frac{1}{32}$ inches), varying from 23 to 29 mm.; strength of single fibers, 5.2 gms.; per cent of lint, 34.

Braddy. PETERKIN GROUP.

South Carolina: Edgefield and Marion counties.

Alabama Bulletin 140. North Carolina Tenth Annual Report (Brady). Congressional Cotton Seed Distribution Leaflet for 1902. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A selection from Simpson made in 1890, by L. C. Braddy, of Dillon, S. C., very similar to Peterkin, but yielding a higher percentage of lint.

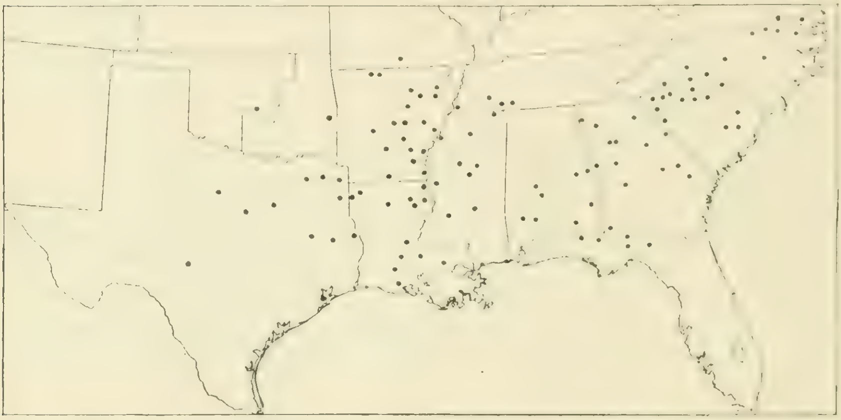

FIG. 12.—Map of the cotton-growing States, showing the distribution of Boyd Prolific cotton in cultivation, as reported in 1907.

Bragg Long-Staple. UPLAND LONG-STAPLE GROUP.

Mississippi Bulletin 23. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now in cultivation. It is said to have been a hybrid between Sea Island and Upland cotton.

Brandon.

A synonym of Brannon.

Brannon.

Arkansas: Lafayette County.

Louisiana: Ascension, Avoyelles, De Soto, East Baton Rouge, East Feliciana, Livingston, Morehouse, Pointe Coupee, St. Helena, St. Landry, Vernon, and West Feliciana parishes.

Mississippi: Amite, Bolivar, Hinds, Jefferson, Lincoln, and Pearl River counties.

Alabama Bulletin 140. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 7, 8, 16, 17, 22, 28, new series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Developed by a selection made nearly forty years ago by G. W. Brannon, formerly of East Feliciana Parish, La. The improvement of this popular variety has been carried on by N. B. Riddle, of Riddle, West Feliciana Parish, a son-in-law of the originator, and by G. Brannon, of Lindsey, East Feliciana Parish. Brannon cotton is generally considered an intermediate between the Upland long-staple and Peterkin groups.

Plants tall and rather slender, limbs 1 to 3 or more, fruiting branches long and rather long jointed, bolls medium to large, seeds medium in size, covered with a short, sparse, brownish-gray fuzz or nearly naked.

The following measurements were obtained from a sample grown at the Louisiana (Baton Rouge) station in 1907:

Bolls per pound, 66; seeds per pound, 4,000; average length of lint, 1 inch; per cent of lint, 32 to 37.

Braswell Cluster, or Braswell Short-Limb. Semicluster Group.

North Carolina: Edgecombe County.

Alabama Bulletin 140.

Developed by David Braswell, of Edgecombe County, about 1883. It was probably a selection from Boyd Prolific. An early-maturing variety with medium-sized bolls and short lint running above the average in percentage.

Brazier. Peterkin Group.

Alabama (Canebrake) Bulletins 11, 14. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A strain of Peterkin introduced by Capt. W. H. Brazier, Uniontown, Ala. Not now in cultivation.

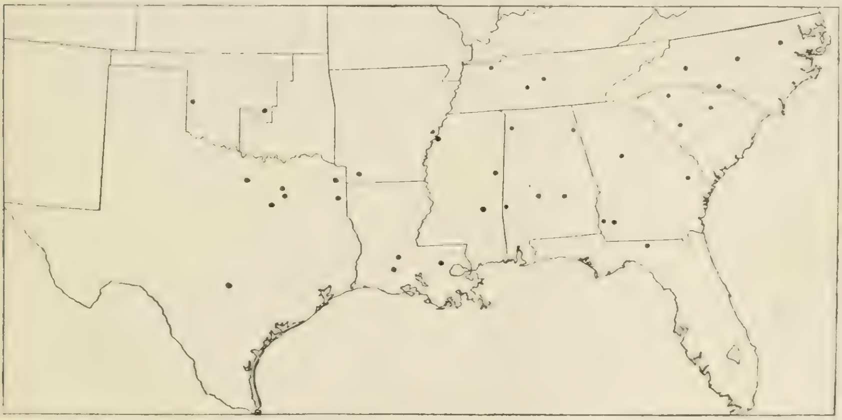

Fig. 13.—Map of the cotton-growing States, showing the distribution of Boykin Stormproof cotton in cultivation, as reported in 1907.

Breadfield. Upland Long-Staple Group.

Reported only from Clarke County, Miss. Originator not known. The seed has been selected and kept pure by M. F. Berry, of Pachuta, Miss., who states that the yield is above the average for "staple" cottons and that the lint is very fine and silky.

Breeden, or Breeden's Prolific. Early Group.

Alabama Bulletin 140. Georgia Bulletin 47. South Carolina Bulletin 120.

Not now grown. It was developed by T. L. Breeden, Lester, S. C.

Broadwell Double-Jointed. Early Group.

Distribution: See map, figure 14.

Georgia Bulletin 75.

A strain of King developed by John B. Broadwell, R. F. D. No. 4, Alpharetta, Ga. It is more productive than King, but otherwise it is very similar. The bolls are small and the cotton falls out too easily during storms, the fruiting branches show a tendency to become irregularly jointed when grown on rich soil, and two bolls are sometimes found close together, but not actually arising from the same joint; flowers often with petal spots; lint of medium length, percentage medium; seeds small, fuzzy, green or brownish gray.

Samples of this cotton grown at the Texas Agricultural Experiment Station, College Station, Tex., and in a variety test at Waco, Tex., were tested as follows:

Bolls per pound, 105; seeds per pound, 4,700 (College Station), 4,500 (Waco); average length of lint, 21 mm. ($\frac{13}{16}$ inch), varying from 18 to 23 mm.; per cent of lint, 32.3 (College Station) and 33.6 (Waco).

Brooks Improved.

(Also known as Brooks "No Name.")

Georgia Bulletins 27, 31. Louisiana Bulletins 17, 22, 28. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Developed by S. L. Brooks, Washington, Ga. A small-boll variety no longer cultivated.

Brown No. 1. BIG-BOLL GROUP.

Alabama: Clay and Greene counties.

Georgia: Meriwether County.

Alabama Bulletin 140. Georgia Bulletins 70, 75.

A strain of Cook's Improved developed by W. L. Brown, Decatur, Ga. The percentage though high is somewhat lower than Cook's Improved, but this is offset by the larger bolls. It is more uniform than the parent variety and resembles the Beat-All tendency to be seen in Cook's Improved.

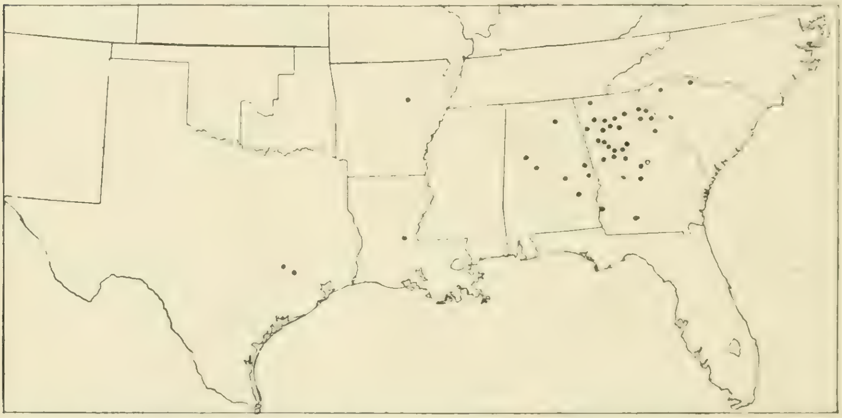

FIG. 14.—Map of the cotton-growing States, showing the distribution of Broadwell Double-Jointed cotton in cultivation, as reported in 1907.

Plant large and stocky in growth, fruiting branches with joints of medium length, showing but little tendency to semicluster, leaves large, bolls more ovate and pointed than those of Cook's Improved, lint rather short; seeds of medium size, fuzzy, brownish or greenish gray.

A sample sent by Mr. Brown gave the following measurements:

Bolls per pound, 48; seeds per pound, 3,600; average length of lint, 22.1 mm. ($\frac{7}{8}$ inch), varying from 19 to 24 mm.; strength of single fibers, 6.3 gms.; per cent of lint, 38.

The above sample was selected for size of boll, average bolls weighing 60 to the pound.

Brown Peterkin. PETERKIN GROUP.

A strain of Peterkin with fuzzy brown seeds in Lincoln County, Ga.

Bryant. UPLAND LONG-STAPLE GROUP.

Reported only from Howard County, Ark. This is said to have been developed in Red River County, Tex., and was formerly grown near Clarksville, Tex. Not tested.

Burke. UPLAND LONG-STAPLE GROUP.

Louisiana: Concordia Parish.

Mississippi: Yazoo County.

Originated by Rev. J. T. Burke, of Benton, Yazoo County, Miss.

Bolls per pound, 71; seeds per pound, 4,000; average length of lint, 33.7 mm. (1-$\frac{11}{32}$ inches), varying from 31 to 35 mm.; strength of single fibers, 3.5 gms.; per cent of lint, 27.6.

Burvine.

Reported only from Hall County, Ga. Not tested.

Butler, or Butler Early.

Alabama: Conecuh County.

Arkansas: Randolph County.

Georgia: Emanuel County.

North Carolina: Mecklenburg County.

South Carolina: Lexington County.

Tennessee: Maury County.

Alabama Bulletin 140.

Originator unknown. A badly mixed strain belonging to no particular group.

Buxkemper. BIG-BOLL STORMPROOF GROUP.

An early big-boll cotton reported from Falls and Bell counties, Tex. Developed by W. Buxkemper, Oenaville, Tex.

Bolls per pound, 51; seeds per pound, 3,300; average length of lint, 22 mm. ($\frac{28}{32}$ inch), varying from 20 to 24 mm.; strength of single fibers, 9 gms.; per cent of lint, 35.7.

Cameron, or Cameron Early.

Alabama: Green County.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 52, 56, 63. Mississippi Bulletins 62, 79; Thirteenth Annual Report.

Originated by R. R. Cameron, West Green, Ala., by crossing Peterkin with Drake Cluster. The plant resembles the former parent, but the percentage of lint is low and the quality somewhat better than Peterkin; seeds fuzzy, brownish gray.

Bolls per pound, 67½; seeds per pound, 4,250; average length of lint, 23 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.4 gms.; per cent of lint, 30.4.

Candell Improved. BIG-BOLL GROUP.

Georgia Bulletin 70.

A local variety not now in cultivation.

Carlisle.

A local variety reported from Marion County, Miss. Developed by John L. Carlisle, Goss, Miss.

Bolls per pound, 69; seeds per pound, 3,850; average length of lint, 24.4 mm. ($\frac{15}{16}$ inch), varying from 21 to 27 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 33.4.

Carolina Pride, or South Carolina Pride.

See Early Carolina.

Carolina Queen.

Alabama Bulletin 140.

Not now in cultivation.

Carr. BIG-BOLL GROUP.

Reported from Duplin County, N. C. Developed by Thomas J. Carr, Rose Hill, N. C., and said to be a cross between Johnson and Russell. Seeds large, fuzzy, green and gray in color.

A sample obtained from the originator tested as follows:

Bolls per pound, 59½; seeds per pound, 3,180; average length of lint, 25.4 mm. (1 inch), varying from 24 to 27 mm.; strength of single fibers, 6.3 gms.; per cent of lint, 32.5.

Catawba.

Mississippi Bulletin 18; Fourth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Originated by W. R. Davis, Lanford, S. C. Not now grown.

Cedar-Bush.

A local variety formerly grown in Tarrant County, Tex. Not reported in 1907.

Chambers.

South Carolina Bulletin 2; First Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Champion.

See Clayton's Champion.

Champion Cluster.

Alabama Bulletin 140. Mississippi Bulletin 62; Second and Fourth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Cheatum.

Alabama Report for 1881–82. Oklahoma Bulletin 23.

Formerly grown in Jones and Navarro counties, Tex., but not reported in 1907. A variety called "Cheatham" was tested by the Alabama experiment station in 1880.

Cheise. BIG-BOLL GROUP.

Alabama Bulletins 107, 140.

A local variety not now in cultivation.

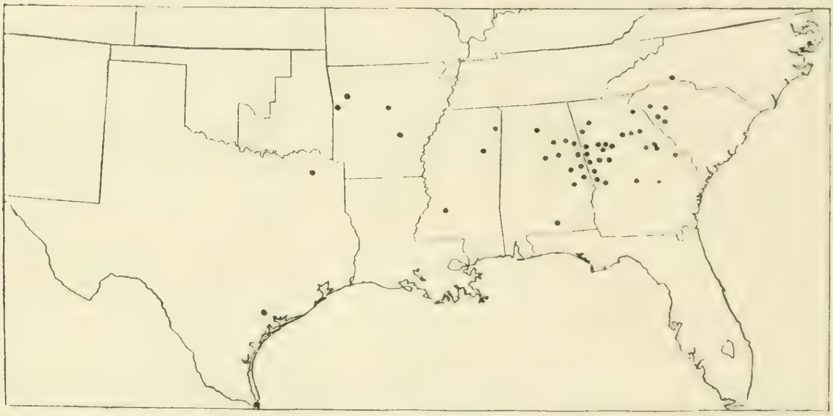

FIG. 15.—Map of the cotton-growing States, showing the distribution of Christopher, or Christopher Improved, cotton in cultivation, as reported in 1907.

Cherry. SEMICLUSTER GROUP.

(Also known as Cherry Cluster and Cherry Long-Staple Prolific.)

Alabama Bulletins 5, 12, 13, 16, 33, 40, 56, 71, 76, 107, 140. Alabama (Canebrake) Bulletins 7, 11, 14. Arkansas Third Annual Report. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 8, 16, new series. Mississippi Bulletins 18, 23, 62; Third and Fourth Annual Reports. Oklahoma Bulletin 23. South Carolina Bulletin 1, old series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. It is said to have been an early variety resembling Peerless.

Chester Improved.

A local variety grown in Lee County, S. C. Not tested.

Christopher, or Christopher Improved. BIG-BOLL GROUP.

Distribution: See map, figure 15.

Alabama Bulletins 107, 138, 140. Georgia Bulletins 43, 47. Congressional Cotton Seed Distribution Leaflet for 1902.

A strain of Wyche or one of its derivatives developed by R. H. Christopher, Asbury, Ga.

Plants pyramidal in shape, somewhat semiclustered in habit of growth, limbs 1 to 2, fruiting branches 18 inches long at the base of the stalk, becoming shorter above, joints short and irregular, leaves large, bolls of good size, rounded, with a blunt apex, seeds large, fuzzy, greenish gray.

Bolls per pound, 60; seeds per pound, 3,425; average length of lint, 23.2 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 33.9.

Claiborne.

A local variety reported only from Baxter County, Ark. Not tested.

Clardy. BIG-BOLL STORMPROOF GROUP.

A local variety reported from Howard County, Ark. It was developed from a cross made eight years ago between Texas Stormproof and King by James W. Clardy, Center Point, Ark., and J. W. Willis, Greenville, Miss. The Clardy is said to be an early, big-boll, stormproof cotton well adapted to weevil conditions. Not tested.

Clark. BIG-BOLL STORMPROOF GROUP.

A large-boll, late-maturing cotton, grown locally in Parker County, Tex. Not tested.

Clark's Improved.

A medium-boll cotton originated by T. V. Clark, Cuthbert, Ga., and grown locally in Randolph County.

Bolls per pound, 75; seeds per pound, 3,980; length of lint, 25.4 mm. (1 inch), varying from 22 to 28 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 33.4.

Clay. UPLAND LONG-STAPLE GROUP.

Origin unknown. A medium long-staple cotton. Not as silky and fine as Sunflower. Not now grown.

Clayton's Champion. BIG-BOLL STORMPROOF GROUP.

Reported from Taylor County, Tex., and Caldwell Parish, La. Developed by G. Clayton, Abilene, Tex. Plant not seen.

Seeds fuzzy, gray or greenish gray; bolls per pound, 77; seeds per pound, 3,950; average length of lint, 24.5 mm. ($\frac{31}{32}$ inch), varying from 23 to 26 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 30.8.

Cleveland. BIG-BOLL GROUP.

(Also known as Cleveland Big-Boll and Cleveland Reimproved.)

Mississippi: Newton and Winston counties.

Alabama Bulletins 138, 140. Georgia Bulletins 35, 75, 79. Mississippi Bulletin 98.

Developed by J. R. Cleveland, Decatur, Miss., by twenty-five years of selection. Plants not uniform, being both semicluster and open in growth, joints of the fruiting branches medium to short, making the variety quite early in maturity, bolls large, 50 per cent 5-locked, not stormproof, lint of medium length, seeds large, fuzzy, light-brownish gray in color.

Bolls per pound, usually 60 (but selected bolls sent by Mr. Cleveland weighed 48 to the pound); seeds per pound, 3,100; average length of lint, 23.5 mm. ($\frac{15}{16}$ inch), varying from 22 to 25 mm.; strength of single fibers, 5.5 gms.; per cent of lint, 35 to 37.

Cliatt, or Cliatt's Improved. BIG-BOLL GROUP.

Alabama Bulletin 140. Georgia Bulletin 47.

A local variety grown in Columbia County, Ga., and developed by R. A. Cliatt, of Grovetown, Ga. Plant not seen.

Bolls per pound, 56; seeds per pound, 3,420; average length of lint, 22.6 mm. ($\frac{29}{32}$ inch), varying from 20 to 25 mm.; strength of single fibers, 7.1 gms.; per cent of lint, 34.3.

Cluster.

(Also known as Multiflora, Moneybush, and Royal Cluster.)

Report of the Patent Office for 1850.

An old variety, not now grown.

Cobweb. UPLAND LONG-STAPLE GROUP.

(Also known as Collin's Cobweb and Spiderweb.)

Arkansas: Lafayette, Phillips, and Saline counties.

Mississippi: Issaquena County.

Tennessee: Chester and Hardin counties.

Developed by W. E. Collins, Mayersville, Miss., about 1878, from a cross between Peeler and Sea Island. Formerly a very fine and silky staple, but now badly mixed with shorter stapled cottons.

A sample from the originator tested as follows:

Bolls per pound, 104; seeds per pound, 4,700; average length of lint, 29.5 mm. ($1\frac{5}{32}$ inches), varying from 26 to 33 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 29.9.

Cochran. SEMICLUSTER GROUP.

(Also known as Cochran's Extra-Prolific and Cochran's Short-Limb Prolific.)

Georgia Bulletins 16, 20. Louisiana Bulletins 21, 22, 28, 29. Mississippi Bulletins 18, 23; Fourth and Sixth Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety tested by the experiment stations about fifteen years ago. Not now grown.

Coleman. SEMICLUSTER GROUP.

(Also known as Coleman Cluster.)

Developed by J. T. Coleman, Graymount, Ga., and reported only from Jenkins County, Ga. Not tested.

Coley. UPLAND LONG-STAPLE GROUP.

Arkansas: Howard and Hempstead counties.

Developed by W. P. Coley, Buck Range, Ark. Plant not seen; lint long, fine, and silky; percentage rather low; seeds of medium size, fuzzy, gray.

Bolls per pound, 73; seeds per pound, 3,650; average length of lint, 33 mm. ($1\frac{5}{16}$ inches), varying from 31 to 34 mm.; strength of single fibers, 5.1 gms.; per cent of lint, 28.6.

Colthorp. UPLAND LONG-STAPLE GROUP.

(Also known as Colthorp Pride, Colthorp Prickle, and Colthorp Eureka.)

See Keno.

Columbia. UPLAND LONG-STAPLE GROUP.

Alabama Bulletin 140. Georgia Bulletin 79.

A selection from Russell made by Dr. H. J. Webber while in charge of Plant Breeding Investigations, U. S. Department of Agriculture, now of Cornell University, Ithaca, N. Y. This variety is remarkable in having been developed from a short-staple cotton on upland soil in South Carolina.

Plant similar to Russell; bolls large, long ovate, 59 per cent 5-locked; lint rather short for a long-staple cotton; needing further selection, as it is not yet uniform; not as silky as Sunflower but stronger; seeds large, fuzzy, gray, a small proportion green. The following measurements are taken from a sample grown at the experiment station, Experiment, Ga., in 1907:

Bolls per pound, $66\frac{1}{2}$; seeds per pound, 3,400; average length of lint, 31.7 mm. ($1\frac{1}{4}$ inches), varying from 27 to 33 mm.; strength of single fibers, 5.6 gms.; per cent of lint, 31.7.

At the Louisiana Experiment Station, Baton Rouge, La., the length of lint averaged 26.8 mm. ($1\frac{1}{16}$ inches), varying from 22 to 30 mm., and at the Texas Agricultural Experiment Station, College Station, Tex., the average length was 28.6 mm. ($1\frac{1}{8}$ inches), varying from 27 to 30 mm.

Commander. UPLAND LONG-STAPLE GROUP.

(Also known as Commander's Pet and Commander's Pride.)

Developed by R. C. Commander, Florence, Florence County, S. C., and also reported from Williamsburg County, S. C. Plant not seen; boll small; lint of fair length, soft, and silky; seeds small, fuzzy, gray.

Bolls per pound, 104; seeds per pound, 4,860; average length of lint, 29.8 mm. ($1\frac{5}{32}$ inches), varying from 25 to 33 mm.; strength of single fibers, 4.1 gms.; per cent of lint, 30.1.

Compton Prolific. BIG-BOLL GROUP.

A local variety grown in Greenwood County, S. C., and developed by H. B. Compton, R. F. D. No. 5, Greenwood, S. C. Plant not seen. Seeds of medium size, fuzzy, greenish or brownish gray.

Bolls per pound, 64; seeds per pound, 4,300; average length of lint, 24.3 mm. ($\frac{15}{16}$ inch), varying from 22 to 26 mm.; strength of single fibers, 6.5 gms.; per cent of lint, 33.

Cook, or J. C. Cook.

Alabama Bulletins 33, 34, 56, 107, 140. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

See Willet Red-Leaf.

Cook Long-Staple. UPLAND LONG-STAPLE GROUP.

Distribution: See map, figure 16.

Alabama Bulletins 22, 33, 34, 40, 52, 56, 71, 76, 107, 130, 140. Georgia Bulletins 11, 20. Louisiana Bulletins 21, 22, 28, 29. Mississippi Bulletins 18, 23, 62, 88, 98; Third Fourth, Sixth, and Eighth Annual Reports. South Carolina Bulletins 18, 120. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Developed by W. A. Cook at Newman, Miss. Seed can now be obtained from Mrs. W. A. Cook, Utica, Miss. Cook has been one of the leading varieties of "staple" cottons for many years and is closely related to Allen.

Plant tall and pyramidal in shape, with 1 to 3 limbs, or often none, fruiting branches showing a tendency to semicluster, but not as short and irregularly jointed as Allen; bolls of medium size, pointed; lint of good length, soft, and silky; seeds of medium size, fuzzy, gray.

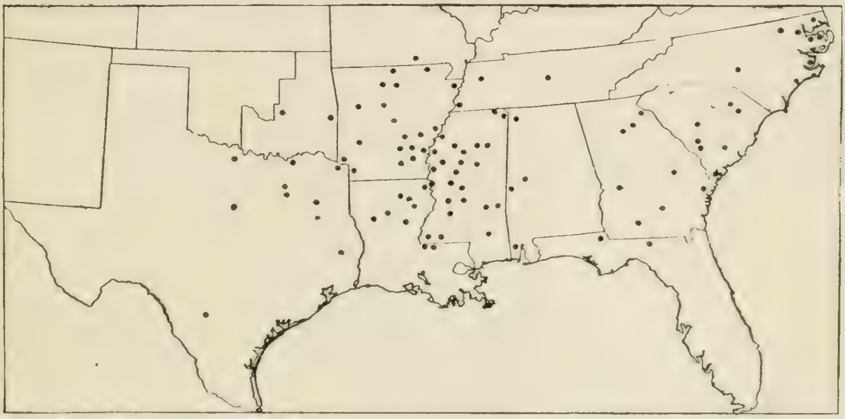

FIG. 16. Map of the cotton-growing States, showing the distribution of Cook Long-Staple cotton in cultivation, as reported in 1907.

A sample grown at the Louisiana Experiment Station in 1907 tested as follows:

Bolls per pound, 60; seeds per pound, 3,650; average length of lint, 31.7 mm. (1¼ inches), varying from 28 to 36 mm.; strength of single fibers, 4.7 gms.; per cent of lint, 28.3.

The bolls of the above sample were larger and the lint shorter than is usual.

Cook's Improved. BIG-BOLL GROUP.

Distribution: See map, figure 17.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 63, 66, 70, 75, 79. Mississippi Bulletins 88, 98. North Carolina State Board of Agriculture Bulletin for September, 1906. Congressional Cotton Seed Distribution Leaflet for 1906.

A medium to large boll variety yielding a high percentage of lint, originated by J. R. Cook, Ellaville, Ga. Mr. Cook states that about 1893 he received from the U. S. Department of Agriculture a bag of cotton seed, the name of which is now unobtainable. He planted it by the side of Beat-All, which he was growing at the time. It proved to be a small-boll cluster cotton resembling Dickson, and was discarded as being less productive than Beat-All. This variety was accidentally hybridized with Beat-All, and the next year Mr. Cook noticed one plant intermediate in type, very high in percentage of lint, and early in maturity. Cook's Improved was developed from this plant, but was not rigorously selected to type. As a result the variety has become a composite of long-branched, large-boll cottons at one extreme, of short-branched or semicluster, small-boll cottons at the other, and a large proportion of plants intermediate between the two. Bolls average medium to large in size, quite round, 54 per cent 5-locked;

lint short, but high in percentage; seeds medium in size, fuzzy, greenish or brownish gray. This variety is liable to injury from boll-rot and also lacks stormproof characters.

The bolls average 60 to 65 per pound, but selected bolls sent by Mr. Cook averaged 53½ per pound; seeds per pound, 4,000; average length of lint, 22 mm. ($\frac{7}{8}$ inch), varying from 20 to 24 mm.; strength of single fibers, 6.8 gms.; per cent of lint, 38.5.

Coppedge. BIG-BOLL GROUP.

(Also known as Coppedge Improved.)

Alabama Bulletins 107, 140. Georgia Bulletin 43.

Developed by C. S. Coppedge, Nyson, Ga. Not now grown.

Corley Wonderful. BIG-BOLL GROUP.

Alabama: Coosa County.

Georgia Bulletin 79.

A strain of Russell developed by selection by W. A. Corley, Kellyton, Ala. It is claimed that this variety yields from 38 to 40 per cent of lint, this being an improvement over Russell, which rarely thirds itself. The sample from Mr. Corley, measurements of which are given below, yielded a good percentage, as did also a sample from the Georgia Experiment Station, but when grown at other experiment stations the percentage was low.

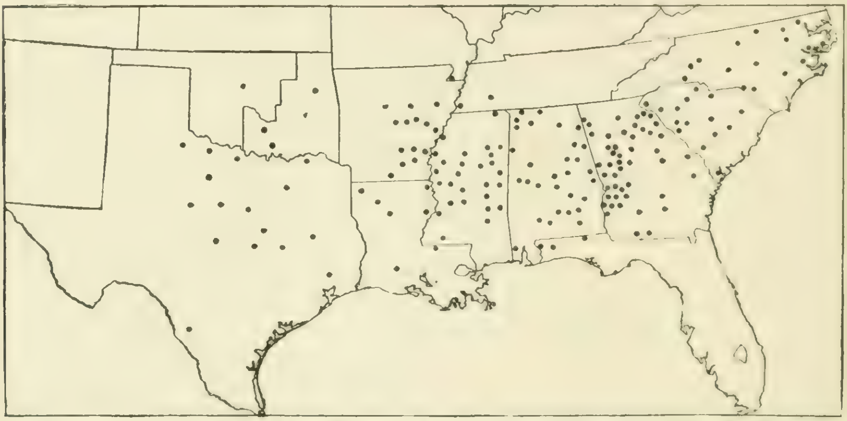

FIG. 17.—Map of the cotton-growing States, showing the distribution of Cook's Improved cotton in cultivation, as reported in 1907.

Plant similar to Russell, bolls large, ranging from 48 to the pound at Baton Rouge, La., to 70 at College Station, Tex.; lint of medium length; seeds large, fuzzy, gray or greenish gray.

Bolls per pound, 48; seeds per pound, 2,950; average length of lint, 25.2 mm. ($\frac{31}{32}$ inch), varying from 22 to 28 mm.; strength of single fibers, 6 gms.; per cent of lint, 36.2.

Corput Find. BIG-BOLL GROUP.

(Also known as Hardwick.)

Arkansas: Desha County.

Georgia: Bartow, Floyd, Gordon, and Macon counties.

Alabama Bulletin 140. Georgia Bulletin 56.

Developed by Felix Corput, of Cave Spring, Ga., from a single plant found in the year 1899. Corput Find was tested by the Georgia station in 1901 and found to be early but not very productive. It has become badly mixed and the bolls are often too small for a big-boll cotton. Seeds large, fuzzy, greenish or brownish gray.

Bolls per pound, 72; seeds per pound, 3,240; average length of lint, 25 mm. ($\frac{31}{32}$ inch); strength of single fibers, 5.4 gms.; per cent of lint, 32.

Cowpen. BIG-BOLL GROUP.

Now reported only from Live Oak County, Tex.; formerly grown also in Nueces and San Patricio counties. The originator is unknown. It is said the variety was developed from a single plant found in a cowpen in northern Texas. Not tested.

Cox. BIG-BOLL GROUP.

Texas: Bosque County.

A big-boll cotton said to have been originated by a Mr. Cox, of China Springs, Tex. Not tested.

Cox Royal-Arch Silk.

Georgia Bulletin 20. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Coxe Yellow-Bloom. PETERKIN GROUP.

Georgia: Cobb County.

North Carolina: Richmond and Scotland counties.

South Carolina: Chesterfield, Marion, and Marlboro counties.

A remarkable variety developed by E. A. Coxe, R. F. D. No. 2, Blenheim, S. C. Mr. Coxe states that about 1895 some Sea Island cotton was grown on his farm near a field of Texas Wood. The Sea Island cotton was not a success and was discarded, but the next year hybrid plants were found, and the seed from one which seemed promising was saved, and the Yellow-Bloom variety was developed from it. In growth it is similar to Texas Oak or Peterkin and is very uniform, except that plants growing taller and more spreading are occasionally found which resemble first-generation hybrids of Sea Island and Upland. Flowers without petal spots, clear lemon-yellow in color; bolls medium in size, 50 per cent 5-locked; lint of fair length, similar to Peterkin in quality, percentage high; seeds small, fuzzy, greenish or brownish gray, or a few nearly smooth.

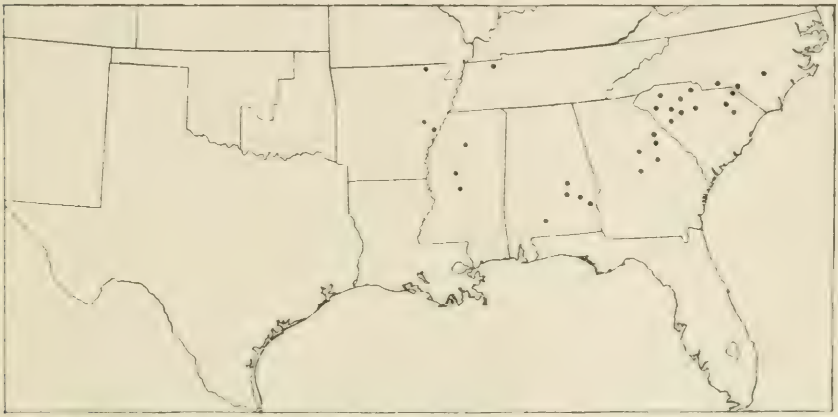

FIG. 18.—Map of the cotton-growing States, showing the distribution of Crossland cotton in cultivation, as reported in 1907.

Bolls per pound, 75; seeds per pound, 4,950; average length of lint, 22.7 mm. ($\frac{7}{8}$ inch), varying from 20 to 25 mm.; strength of single fibers, 6 gms.; per cent of lint, 39.5.

Crawford.

(Also known as Crawford Peerless and Crawford Improved.)

Alabama Bulletins 76, 140. Arkansas First and Second Annual Reports. Louisiana Bulletins 21, 22, 26, 27, old series; 8, 16, 21, 29, new series. Mississippi Second Annual Report. South Carolina Bulletins 1, old series; 2, new series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now in cultivation. Originator unknown.

Crawford Double-Boll.

A local variety grown in Pierce County, Ga. Not tested.

Crosby.

A local variety reported only from Greenville County, S. C. Not tested.

Cross.

Reported only from Choctaw County, Okla. Not tested.

Crossland.

Distribution: See map, figure 18.

Alabama Bulletins 40, 107, 130, 138, 140. Alabama (Tuskegee) Bulletin 7. Alabama (Wetumpka) First Annual Report. South Carolina Bulletins 1, old series; 2, 120, new series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Originator unknown. When tested by the Alabama station in 1892 it was a Peterkin variety, yielding a good percentage of lint. A poor strain of long-staple Upland cotton is also sold under this name.

Cuban Silk.

Reported only from Hall County, Tex. Not tested.

Culpepper. BIG-BOLL GROUP.

(Also known as Culpepper Improved and Culpepper Improved Prolific.)

Distribution: See map, figure 19.

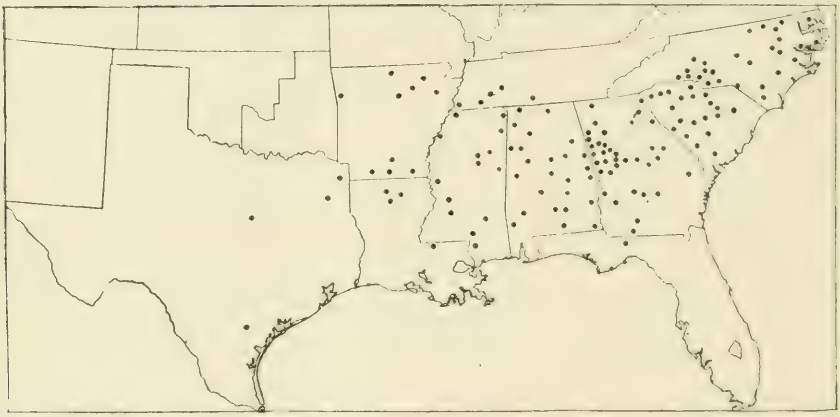

FIG. 19.—Map of the cotton-growing States, showing the distribution of Culpepper cotton in cultivation, as reported in 1907.

Alabama Bulletins 101, 107, 130, 138, 140. Alabama (Tuskegee) Bulletin 7. Georgia Bulletins 39, 43, 47, 52, 56, 59, 63, 66, 70, 75. Louisiana Bulletin 71. Mississippi Bulletin 98; Fifteenth Annual Report. North Carolina State Board of Agriculture Bulletin for September, 1906. South Carolina Bulletin 120. Congressional Cotton Seed Distribution Leaflets for 1902, 1904, and 1905.

Developed by J. E. Culpepper, Luthersville, Ga., by mixing seed of Wyche and Dickson. These dissimilar varieties have blended by hybridization into a fairly uniform intermediate cotton, still showing, however, a few plants approaching the parents in character of growth. The cross was made about 1890.

Plants usually semicluster in habit of growth, with 1 to 3 long limbs and with fruiting branches shortly and irregularly jointed. Bolls large, rounded; lint of medium length, percentage good, seeds large, fuzzy, greenish or brownish gray in color.

Like Cook's Improved, to which it is related through its parent Dickson, Culpepper is liable to injury from anthracnose or boll-rot.

Bolls per pound, 50; seeds per pound, 3,380; average length of lint, 22.5 mm. ([illegible] inch), varying from 21 to 24 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 35.1.

Cummings. BIG-BOLL GROUP.

Distribution: See map, figure 20.

Alabama Bulletins 107, 140.

Developed by Bartow Cummings, Strand, Ala. Plants not uniform, open and long branched or a few semiclustered in habit of growth, bolls medium to large, lint of medium length, seeds large, fuzzy, gray or greenish gray in color.

Bolls per pound, 68; seeds per pound, 3,000; average length of lint, 1 inch; strength of single fibers, 6.1 gms.; per cent of lint, 31.6.

Dalkeith, or Dalkeith Eureka. UPLAND LONG-STAPLE GROUP.

Arkansas: Pulaski County.

Alabama Bulletins 40, 52, 107. Louisiana Bulletins 29, 35. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

See Keno.

Daniel Big-Boll.

A local variety reported from Early County, Ga. Not tested.

Davis. BIG-BOLL STORMPROOF GROUP.

Reported from Denton and Grayson counties, Tex. A large-boll variety with good stormproof qualities, very similar to Texas Stormproof. It was developed by W. A. Davis, of Bells, Tex.

Plant large and vigorous, leaves large, fruiting branches fairly short jointed, drooping, bolls usually hanging downward, lint of good length, seeds large, fuzzy, grayish white.

Bolls per pound, 54; seeds per pound, 3,200; average length of lint, 1 inch; strength of single fibers, 6.3 gms.; per cent of lint, 33.

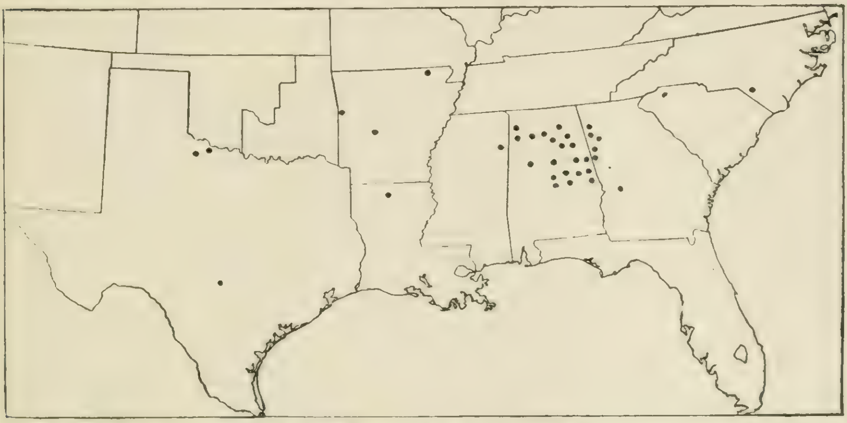

FIG. 20.—Map of the cotton-growing States, showing the distribution of Cummings cotton in cultivation, as reported in 1907.

Davis Long-Staple. UPLAND LONG-STAPLE GROUP.

Florida: Taylor County.

Mississippi: Bolivar and Tallahatchie counties.

Tennessee: Haywood and Shelby counties.

Alabama Bulletin 140. Mississippi Bulletins 79, 84; Fifteenth and Seventeenth Annual Reports.

Developed by the Davis Brothers, Bailey, Shelby County, Tenn. Tested by the Mississippi Agricultural Experiment Station, 1901, where it yielded 28.6 per cent of lint which was 1¼ inches in length.

Dean, or Deane. PETERKIN GROUP.

South Carolina Bulletin 2; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture. Report of the Patent Office for 1853.

An old variety not now in cultivation.

Dearing. PETERKIN GROUP.

(Also known as Dearing Small-Boll and Dearing Small-Seed.)

Alabama: Marion County.

Arkansas: Union County.

Georgia: Morgan and Newton counties.

Alabama Bulletins 76, 89, 101, 107, 140. Arkansas Bulletin 18. Georgia Bulletins 24, 27, 31. Louisiana Bulletins 26, 27, old series; 8, 62, new series. Mississippi Bulletins 18, 62; Fourth, Twelfth, and Thirteenth Annual Reports. South Carolina Bulletins 1, old series; 2, new series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety, formerly more widely grown, developed about 1870 by J. J. Dearing, of Covington, Ga. When pure, this variety resembled Peterkin and yielded a high percentage of lint, but as now grown it is nondescript in character.

Diamond.

Alabama Bulletin 140. South Carolina Bulletin 2; Second Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety not now in cultivation.

Dickson Improved. CLUSTER GROUP.

(Also known as Dickson Cluster and Dixon.)

Distribution: See map, figure 21.

Alabama Bulletins 33, 40, 56, 76, 89, 107, 138, 140; Report for 1881-82. Alabama (Canebrake) Bulletin 22; Twelfth and Thirteenth Annual Reports. Georgia Bulletins 11, 16, 20, 27, 31, 43. Louisiana Bulletins 21, 22, 26, 27, old series; 7, 8, 16, 17, 21, 22, 28, 29, 47, new series; Third and Fourth Annual Reports. Mississippi Bulletins 18, 23, 62; Third, Fourth, Sixth, Eighth, Twelfth, Thirteenth, and Fifteenth Annual Reports. Oklahoma Bulletin 23. South Carolina Bulletin 1, old series; 18, 42, 120, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

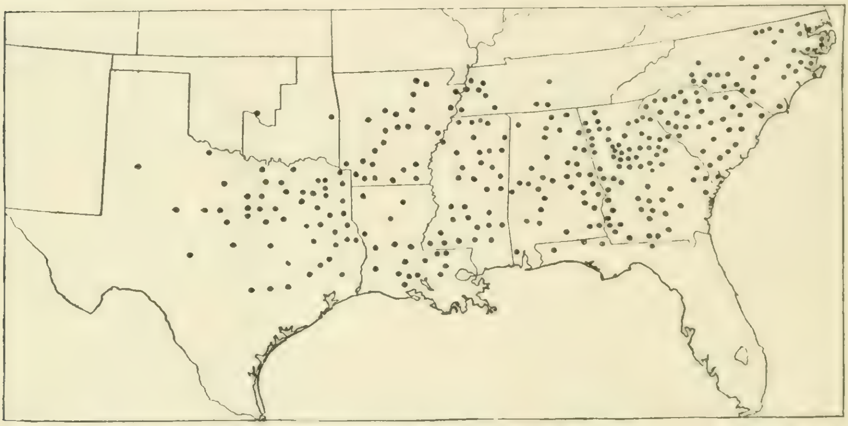

FIG. 21.—Map of the cotton-growing States, showing the distribution of Dickson Improved cotton in cultivation, as reported in 1907.

Developed about the year 1858 by David Dickson, of Oxford, Ga. It was formerly a very popular variety and is still grown in nearly all parts of the cotton belt, though less extensively every year, perhaps on account of its liability to injury from anthracnose and to the growing aversion to cluster cottons.

Plants early maturing, of the strict cluster type, with 1 to 3 long limbs, the fruiting branches reduced to spurs by shortening of the internode, thus throwing the nodes or joints very close together, spurs 2 to 6 inches long, usually longer in the middle of the stalk than at the bottom or top, leaves very large, bolls clustered, small, rounded in shape, lint of medium length, seeds small, fuzzy, brownish gray.

Bolls per pound, 105; seeds per pound, 5,670; average length of lint, 22 mm. (⅞ inch); strength of single fibers, 5.1 gms.; per cent of lint, 29 to 32.

Dillard.

A local variety formerly grown quite extensively in Laurens County, Ga. Not tested.

Dillon. CLUSTER GROUP.

Farmers' Bulletin 333, U. S. Dept. of Agriculture.

A wilt-resistant variety developed by careful breeding under the direction of W. A. Orton, of the Department of Agriculture, from selections from Jackson Limbless made in 1900 at Dillon, S. C.

Like all cluster varieties, difficult to pick free from trash, but, owing to its resistance to wilt, its stormproof character, and its productiveness, it is becoming popular on wilt-infected soils in the coastal-plain belt from North Carolina to Alabama.

Plant tall, erect, wilt resistant, often with one or two large ascending branches from the base, fruiting limbs reduced to short spurs crowding the short-stemmed bolls into clusters; seeds small, covered with close brownish green fuzz.

Bolls per pound, 94; seeds per pound, 5,320; average length of lint, 22 mm. ($\frac{7}{8}$ inch); per cent of lint, 37.

Dixie. PETERKIN GROUP.

Alabama Bulletin 140. Farmers' Bulletin 333. U. S. Dept. of Agriculture.

A wilt-resistant variety developed from a selection made at Troy, Ala., in 1902, and bred by the progeny-row method under the direction of W. A. Orton, of the Department of Agriculture. The primary object in the development of this variety was to secure plants resistant to cotton wilt. The selection has been continued until a variety not only resistant to wilt but productive and of uniform type has been secured.

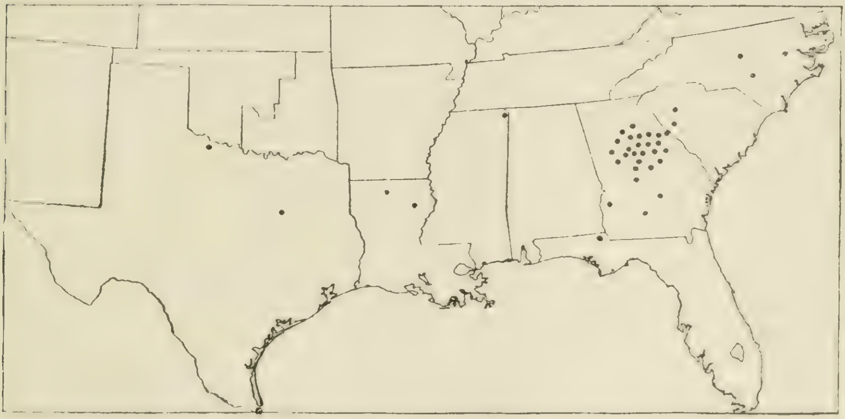

FIG. 22.—Map of the cotton-growing States, showing the distribution of Dongola, or Gondola, cotton in cultivation, as reported in 1907.

Plant nearly of Peterkin type, pyramidal, with large basal limbs and long, slender, fruiting branches, leaves medium sized, bolls medium, seeds small, variable in color but typically covered with greenish brown fuzz.

Bolls per pound, 73; seeds per pound, 4,100; average length of lint, 25 mm. (1 inch), varying from 20 to 27 mm.; per cent of lint, 36.

Dixie Long-Staple. UPLAND LONG-STAPLE GROUP.

Arkansas: Hempstead County.

Mississippi: Holmes County.

North Carolina: Granville County.

Introduced by Humphreys, Godwin & Co., of Memphis, Tenn., in 1907. Not tested.

Dixon. CLUSTER GROUP.

See Dickson Improved.

Dongola, or Gondola. BIG-BOLL GROUP.

Distribution: See map, figure 22.

Alabama Bulletin 140. Georgia Bulletins 59, 66.

Said to have been originated by a Mr. Dongola, of Texas, but selected and developed by B. F. Malabar, of Waynesboro, Ga. A popular variety in central Georgia, but hardly known outside of the State.

Plant of the big-boll type, stocky and vigorous in growth with a tendency toward the semicluster habit; bolls large, rounded, with a short point; lint of good length; seeds large, fuzzy, light brownish gray.

The following measurements were obtained from a sample grown at the Georgia Experiment Station in 1907. The percentage of lint is usually 2 per cent higher than shown in this test:

Bolls per pound, 57; seeds per pound, 3,025; average length of lint, 25.3 mm. (1 inch), varying from 23 to 29 mm.; strength of single fibers, 6 gms.; per cent of lint, 30.2.

Dooley's Improved.

Texas Bulletins 34, 40, 45, 50.

Not now grown.

Double-Header. BIG-BOLL GROUP.

Georgia: Bartow, Clinch, Jasper, and Putnam counties.

Oklahoma: Creek Nation.

Missouri: Taney County.

Texas: Erath and Jones counties.

Alabama Bulletin 140. Georgia Bulletin 75.

Developed by R. H. Smith, R. F. D. No. 2, Monticello, Ga. Mr. Smith states that this cotton is the result of seven years' selection from a green and white seed cotton. It is probably a strain of Russell, but bears some resemblance to Mask's Green-Leaf.

Plants rather tall and with a tendency toward the semicluster habit of growth; limbs 1 to 2, heavy; branches somewhat semiclustered; leaves large, remaining green late in the season; bolls large with thick hulls, thus retaining the Russell character of partial immunity to insect depredations; percentage of lint medium to low; seeds large, fuzzy, green or gray.

Bolls per pound, 54; seeds per pound, 3,310; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 27 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 33.3.

Doughty. UPLAND LONG-STAPLE GROUP.

(Also known as Doughty's Improved, Doughty's Extra-Long-Staple.)

Georgia: Jefferson County.

Louisiana: Concordia Parish.

Mississippi: Hinds County.

Alabama Bulletins 107, 130, 140. Alabama (Canebrake) Twelfth and Thirteenth Annual Reports. Georgia Bulletin 35. Louisiana Bulletins 62, 71. Mississippi Bulletin 79; Twelfth Annual Report. South Carolina Bulletin 120. Texas Bulletin 50.

Originator unknown. Doughty was formerly grown quite extensively but has become so badly mixed with short-staple cotton that it can barely be classed as a "quarter" cotton. It was tested in 1901 by the Mississippi experiment station, when the lint measured 1½ inches, the percentage, however, being very low.

Plants of medium height, rather slender and somewhat semiclustered in habit of growth, leaves of medium size, bolls rather small, pointed, lint quite soft and silky, percentage low, seeds fuzzy, gray or greenish gray.

The following measurements were obtained from a fairly pure sample grown at the Louisiana (Baton Rouge) Experiment Station in 1907:

Bolls per pound, 79; seeds per pound, 4,100; average length of lint, 30.9 mm. ($1\frac{7}{32}$ inches), varying from 27 to 35 mm.; strength of single fibers, 5 gms.; per cent of lint, 28.9.

Dozier Improved. EARLY GROUP.

Alabama Bulletin 140. North Carolina State Board of Agriculture Bulletin for September, 1906.

Developed by M. D. Dozier, Camden, N. C., who states that it is an early, short-jointed cotton. Plant similar to King, or Sugar-Loaf.

Bolls per pound, 73; seeds per pound, 4,175; average length of lint, 23.2 mm. ($\frac{29}{32}$ inch), varying from 21 to 25 mm.; strength of single fibers, 5.7 gms.; per cent of lint, 33.1.

Drake. SEMICLUSTER GROUP.

(Also known as Drake's Cluster.)

Distribution: See map, figure 23.

Alabama Bulletins 107, 130, 140. Louisiana Bulletins 21, 22, 28, 29. Mississippi Bulletins 18, 23, 62, 79; Third, Fourth, Sixth, Eighth, and Fifteenth Annual Reports. Oklahoma Bulletin 23. South Carolina Bulletins 18, 42, 120. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A strictly semicluster, early variety originated by R. W. Drake, Laneville, Ala., and like many in this group liable to injury from anthracnose.

Plant pyramidal in shape, with one or more limbs, bearing rather short fruiting branches with short and irregular joints, leaves medium in size, bolls medium to large, seeds rather small, fuzzy.

Bolls per pound, 81; seeds per pound, 4,490; average length of lint, 22.9 mm. ($\frac{29}{32}$ inch), varying from 20 to 25 mm.; strength of single fibers, 6 gms.; per cent of lint, 30.9.

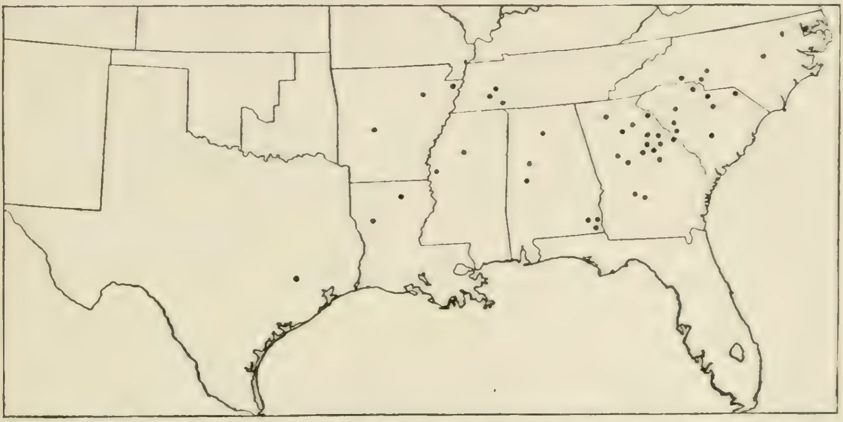

FIG. 23.—Map of the cotton-growing States, showing the distribution of Drake cotton in cultivation, as reported in 1907.

Drake's Defiance. SEMICLUSTER GROUP.

(Also known as World's Wonder.)

Georgia: Fayette and Meriwether counties.

North Carolina: Scotland County.

Alabama Bulletin 140. Georgia Bulletin 75.

A highly advertised variety recently introduced by Drake Brothers, Philomath, Ga., and by Humphreys, Godwin & Co., Memphis, Tenn., the latter firm selling the seed under the trade name of "World's Wonder" and claiming it to be a new species, etc. It resembles other medium-boll, semicluster varieties and, like them, is prolific when grown on rich, well-cultivated soils, showing little or no tendency to become "weedy" in growth. The size of bolls in 1907 ranged from 66 per pound at Baton Rouge, La., to 84 at College Station, Tex.; the per cent of lint, from 29.4 at College Station, Tex., to 34.3 at Auburn, Ala.

The following measurements were obtained from a sample picked on Mr. Drake's farm, in Philomath, Ga.

Bolls per pound, 63; seeds per pound, 4,100; average length of lint, 23.6 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; strength of single fibers, 6.6 gms.; per cent of lint, 34.7.

Duncan. BIG-BOLL GROUP.

(Also known as Duncan's Mammoth and Duncan's Mammoth Big-Boll Prolific.)

Alabama: Cleburne, Marshall, Perry, and Talladega counties.

Arkansas: Independence, Phillips, and Saline counties.

Georgia: Carroll, Paulding, and Webster counties.

Mississippi: Carroll, De Soto, Itawamba, Simpson, and Yalobusha counties.

North Carolina: Mecklenburg and Rutherford counties.

South Carolina: Aiken, Anderson, Florence, Laurens, Marlboro, Oconee, and Orangeburg counties.

Tennessee: Shelby County.

Texas: Baylor and Howard counties.

Alabama Bulletins 76, 89, 107, 140. Arkansas Third Annual Report. Georgia Bulletins 20, 24, 27, 31, 35. Mississippi Bulletins 62, 83; Third, Twelfth, and Thirteenth Annual Reports. South Carolina Bulletin 1, old series; First and Second Annual Reports. Texas Bulletin 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

This was quite a popular variety about fifteen years ago and is still grown to some extent, but the seed has become badly mixed and the bolls are almost too small to be included in the big-boll group.

Bolls per pound, 68; seeds per pound, 3,050; average length of lint, 26 mm. ($1\frac{1}{32}$ inches); strength of single fibers, 5 gms.; per cent of lint, 30.

Dunlap's Stormproof. BIG-BOLL STORMPROOF GROUP.

Arkansas: Drew County.

Georgia Bulletin 79.

A selection from Banny Brown made by B. Z. Dunlap, Wilmar, Ark. Plant large and vigorous, limbs 1 to 3, heavy; fruiting branches long jointed; leaves large and dark green; bolls large, 65 per cent 5-locked; seeds large, fuzzy, gray or greenish gray.

The following measurements were made from a sample grown at the Georgia station in 1907:

Bolls per pound, 66; seeds per pound, 3,950; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 21 to 27 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 35.5.

Dunn's Pet.

A local variety from Dallas County, Ark. Not tested.

Durham [R. L.]. BIG-BOLL GROUP.

Georgia: Oconee County.

A strain of Truitt selected for larger bolls and stormproof characters by R. L. Durham, Farmington, Ga.

Plant open or somewhat semiclustered in habit of growth, with 1 to 3 heavy, strong limbs and fruiting branches fairly short jointed; bolls large to very large; seeds large, fuzzy, gray.

Bolls per pound, 48; seeds per pound, 3,125; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 25 mm.; strength of single fibers, 6 gms.; per cent of lint, 33.3.

Durham [S. L.]. BIG-BOLL GROUP.

Georgia: Harris County.

Georgia Bulletin 79.

Developed about 1902 by S. L. Durham, of Chipley, Ga., from a mixture of Russell and Christopher.

Plants large and vigorous with a tendency toward the semicluster habit, limbs strong, fruiting branches rather short and irregularly jointed, leaves large and dark green; bolls large, 30 per cent 5-locked; seeds large, fuzzy, grayish brown.

The following measurements were obtained from a sample grown at the Georgia station in 1907:

Bolls per pound, 62; seeds per pound, 3,360; average length of lint, 22.9 mm. ($\frac{29}{32}$ inch), varying from 21 to 25 mm.; strength of single fibers, 5.8 gms.; per cent of lint, 33.7.

Early Carolina. EARLY GROUP.

(Also known as Extra-Early Carolina and Carolina Pride.)

Alabama Bulletin 140. Louisiana Bulletins 22, 27, old series; 8, 16, 28, new series. Mississippi Bulletins 18, 62; Third, Fourth, and Eighth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Early Gayosa.

Alabama Bulletin 140.

A synonym of Gayosa Prolific.

Early Green.

A local variety reported from Tyrrell County, N. C. Not tested.

Early Mammoth.

Reported only from Dekalb County, Ala. Not tested.

Early May.

Reported only from Cleveland County, Ark. Not tested.

Early Sugar-Loaf. EARLY GROUP.

See Sugar-Loaf.

Eason Beauty. UPLAND LONG-STAPLE GROUP.

Alabama: Marion County.

Texas: Hardin County.

A long-staple cotton said to have been originated in Cobb County, Ga.

Plant tall and slender; limbs 1 to 3; fruiting branches slender, of medium length, with little or no tendency toward the semicluster habit; leaves medium in size; bolls small; lint fine and silky, of good length; seeds fuzzy, brownish gray.

Bolls per pound, 85; seeds per pound, 4,075; average length of lint, 35 mm. ($1\frac{3}{8}$ inches); strength of single fibers, 3.7 gms.; per cent of lint, 29.

East.

Louisiana Bulletins 26, old series; 8, 16, new series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety tested by the Louisiana station in 1889 and said to have been originated by a Mr. East, of Slaughter, La. Not now grown.

Easterling.

A local variety formerly grown to some extent in Nevada County, Ark. Not tested.

Eclipse.

Alabama: Logan and Marion counties.

Arkansas: Sharp County.

Florida: Madison County.

Georgia: Banks, Bryan, and Butler counties.

Louisiana: Ouachita Parish.

Mississippi: Amite County.

North Carolina: Anson, Harnett, Moore, and Stanley counties.

South Carolina: Florence and Lexington counties.

Tennessee: Chester county.

Texas: Jack County.

Alabama Bulletin 140.

Tested by the Alabama station in 1902 and stated to have all the characteristics of a long-staple cotton except length of lint. As grown at the Louisiana station (Baton Rouge) in 1907, Eclipse was a very uniform, early-maturing, and prolific variety yielding short lint. The measurements of this cotton are as follows:

Bolls per pound, 90; seeds per pound, 4,530; average length of lint, 22.6 mm. ($\frac{29}{32}$ inch), varying from 20 to 25 mm.; per cent of lint, 33.5.

Edgewood.

North Carolina State Board of Agriculture Bulletin for September, 1906.

Tested by the North Carolina State Board of Agriculture in 1905. Perhaps a misprint for Edgeworth.

Edgeworth.

North Carolina: Gaston County.

Alabama Bulletins 130, 140. Georgia Bulletin 52. Mississippi Bulletins 84, 88, 98; Seventeenth Annual Report.

Developed by J. C. Little, of Louisville, Ga. A variety related to the Peterkin group but lacking in uniformity. Plants both open and semicluster in habit of growth; seeds fuzzy, gray or brownish gray.

Bolls per pound, 71; seeds per pound, 3,660; average length of lint, 23.2 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 5.2 gms.; per cent of lint, 36.3.

Edson. Big-Boll Group.

A strain of Eudaly, selected for earliness by A. W. Edson, formerly of the Department of Agriculture, but unfortunately not perfected at the time of his death. It has recently been introduced into the weevil regions of Texas and is early in season, being but a few days later than King, but is not as perfectly stormproof as Rowden.

Plants large-growing and vigorous, fruiting branches fairly short jointed; leaves medium to large in size; bolls medium to large, lint of fair length; seeds large, fuzzy, gray in color.

Bolls per pound, 65; seeds per pound, 3,540; average length of lint, 22.9 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; per cent of lint, 33.3.

Edwards. Big-Boll Group.

Texas: Delta and Lamar counties.

Originator not known. A large-boll cotton said to be some ten days later than Rowden and to yield 33⅓ per cent of strong lint about 1 inch in length. It was taken to Texas from North Carolina.

Edwards. Early Group.

A short-staple cotton formerly grown in Holmes County, Miss. It is said to have been very early in maturity, yielding 33.3 per cent of lint. The seeds were small and nearly naked. Not now grown.

Edward's Improved.

Georgia Bulletin 43.

Not now grown. It was developed by T. J. Edwards, Hampton, Ga.

Eldorado. Upland Long-Staple Group.

Arkansas Bulletin 58.

A variety distributed by the Department of Agriculture in 1900. It was tested by the Arkansas station, at Newport, Ark., in 1898, and promised well but did not become popular and soon disappeared from cultivation.

Ellerbe.

(Also known as Ellerbe's Choice, Ellerbe's Big-Stalk, and Ellerbe's Prolific.)

Georgia Bulletins 24, 27, 31.

Not now grown. C. A. Ellerbe, Hagood, S. C., was the originator. This cotton, under the above names, was tested by the Georgia station in 1893-94, and the following measurements given:

Ellerbe's Big-Stalk: Bolls per pound, 75 to 80; per cent of lint, 33.9. Ellerbe's Choice: Bolls per pound, 73 to 77; per cent of lint, 32.2. Ellerbe's Prolific: Bolls per pound, 74 to 80; per cent of lint, 32.6.

Ellis. Big-Boll Group.

Alabama Bulletins 107, 140. Georgia Bulletins 43, 47.

A large-boll cotton formerly grown in Georgia and said to be identical with Culpepper. Originated by J. B. Ellis, Palalto, Ga.

Ellison's Select.

South Carolina Bulletin 120.

Tested by the South Carolina station in 1905. Not reported in 1907.

Ellsworth.

Alabama Bulletins 13, 16, 107. Louisiana Bulletins 27, old series; 7, 8, 16, 17, 22, new series. Mississippi Bulletin 18; Second and Fourth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety, not now grown, tested by several experiment stations about eighteen years ago. The originator was W. N. Ellsworth, Wallace, N. C.

Ethridge Small-Seed.

Louisiana Bulletins 8, 16, 21, 29. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. It was originated by W. B. Ethridge, of Dounsville, La.

Eudaly. Big-Boll Stormproof Group.

Texas: Hamilton County.

A strain of Myers developed by selection by G. W. Eudaly, Olin, Tex. Not tested.

Eureka. UPLAND LONG-STAPLE GROUP.

Arkansas: Ashley County.

Mississippi: Yazoo County.

Tennessee: Dyer County.

Alabama Bulletin 140. Louisiana Bulletins 16, 21, 29. Mississippi Bulletins 18, 23, 62; Fourth, Sixth, and Eighth Annual Reports. South Carolina Bulletins 1, old series; 2, 18, new series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

See Keno.

Excelsior. PETERKIN GROUP.

Distribution: See map, figure 24.

Alabama Bulletins 76, 107, 140. Alabama (Tuskegee) Bulletin 7. Georgia Bulletins 43, 56, 59. Louisiana Bulletins 21, 22, 28, 29, 62, 71. Mississippi Bulletins 18, 62, 84, 87, 98; Second, Third, Fourth, Thirteenth, and Seventeenth Annual Reports. North Carolina State Board of Agriculture Bulletin for September, 1906. South Carolina Bulletins 1, old series; 2, 42, 120, new series; First and Second Annual Reports. Congressional Cotton Seed Distribution Leaflet for 1903. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

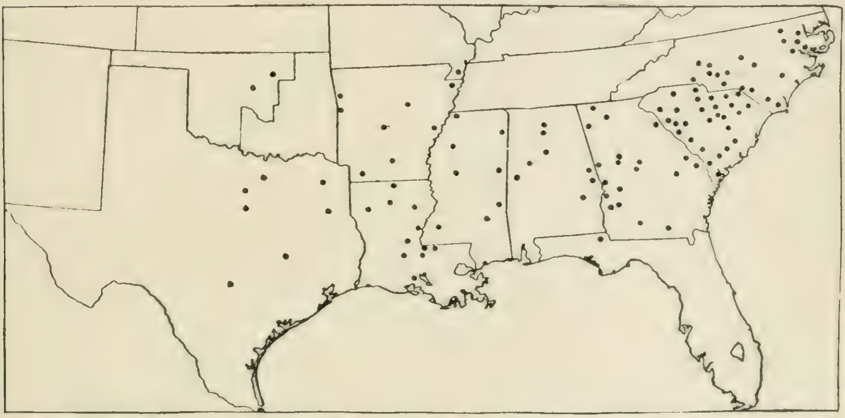

FIG. 24.—Map of the cotton-growing States, showing the distribution of Excelsior cotton in cultivation, as reported in 1907.

A strain of Peterkin, sold by C. F. Moore, Excelsior Seed Farm, Bennettsville, S. C. The variety seems to be distinct from Peterkin only in its low percentage of lint.

A sample grown at the Louisiana Experiment Station in 1907 and tested by the Department of Agriculture yielded 31.8 per cent of lint. A sample grown at the Texas station the same season yielded 33 per cent.

Excelsior [Ezell].

Mississippi Bulletin 18.

Originated by C. R. Ezell, at Eatonton, Ga. Not now grown.

Ezelle's Surprise. BIG-BOLL GROUP.

Developed by C. R. Ezelle, Willard, Ga. A sample obtained from the originator tested as follows:

Bolls per pound, 50½; seeds per pound, 3,175; average length of lint, 23.6 mm. ($\frac{15}{16}$ inch), varying from 21 to 25 mm.; strength of single fibers, 5.4 gms.; per cent of lint, 34.3.

Farm View Green-Seed. BIG-BOLL GROUP.

A strain of Russell developed by W. D. Osborn, Goldville, Ala. Percentage of lint somewhat higher than Russell, seeds large, fuzzy, green.

Bolls per pound, 52; seeds per pound, 3,450; average length of lint, 23.4 mm. ($\frac{29}{32}$ inch), varying from 20 to 25 mm.; strength of single fibers, 6.9 gms.; per cent of lint, 35.4.

Farmer's Relief.

A local variety reported only from Greene County, Ark. Not tested.

Farrar Forked-Leaf.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

See Okra.

Featherstone. BIG-BOLL GROUP.

Georgia: Monroe County.

North Carolina: Cleveland and Lincoln counties.

Alabama Bulletin 140. Georgia Bulletin 70.

An old variety. In North Carolina it is said to be a big-boll, white-seed variety with long branches. It was very popular until Russell and Truitt were introduced but has given place to these varieties. It is stated that in Monroe County, Ga., it is similar to Dickson Cluster. As tested by the Alabama station it was a large-boll cotton.

Felder Little-Seed. PETERKIN GROUP.

Reported only from Lee County, Ga.

Ferguson, or Furguson.

Mississippi: Claiborne and Warren counties.

Alabama Bulletin 140.

Developed by James Ferguson, formerly of Warren County, Miss. Not tested.

Ferrell's Prolific.

Mississippi Bulletin 62; Second, Eighth, and Fourteenth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Fields.

Reported only from Cooke County, Tex. Not tested.

Finch's Improved.

A local variety grown in Nash County, N. C. Not tested.

Five-In-Hand. BIG-BOLL GROUP.

Reported only from Gonzales County, Tex. Not tested.

Flemming. UPLAND LONG-STAPLE GROUP.

Alabama: Dallas County.

Arkansas: Lafayette County.

North Carolina: Anson and Granville counties.

Texas: Hill and Red River counties.

Developed by Mordecai Flemming, Clarksville, Red River County, Tex. A long-staple cotton resembling Boozer but with larger bolls.

Bolls per pound, 66; seeds per pound, 3,200; average length of lint, 28 mm. ($1\frac{3}{32}$ inches), varying from 22 to 32 mm.; strength of single fibers, 6 gms.; per cent of lint, 29.

Floradora. UPLAND LONG-STAPLE GROUP.

Distribution: See map, figure 25.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 24, 66, 79. North Carolina State Board of Agriculture Bulletin for September, 1906.

This variety, which was probably Allen Long-Staple to begin with, was taken from the Mississippi Delta region to Barnwell, S. C., by a cotton buyer named Coffin. It was grown by Mrs. W. Gilmore Simms, of Barnwell, and has been sold for several years as Simms Long-Staple. L. A. Stoney, of Allendale, Barnwell County, recognized the value of Simms cotton, and under the new name, Floradora, he has successfully introduced it into cultivation throughout the cotton belt. In order to increase the size of boll and length of staple Mr. Stoney has mixed big-boll and Allen Long-Staple seed with the Simms or Floradora seed and it has to some extent lost its identity. At Baton Rouge, in 1907, the bolls were large, 60 per pound, but the lint was less than an inch in length. At the Georgia station, on the other hand, the bolls were small, 91 per pound, and the lint measured $1\frac{1}{32}$ inches and was fine and silky.

A sample obtained at the Alabama station was intermediate and the measurements were as follows:

Bolls per pound, 80; seeds per pound, 3,900; average length of lint, 27.7 mm. ($1\frac{3}{32}$ inches), varying from 25 to 30 mm.; strength of single fibers, 4.5 gms.; per cent of lint, 30.5

Forty-Boll.

A local variety grown in Catawba County, N. C.

Foster. Upland Long-Staple Group.

Louisiana Bulletin 28.

Tested by the Louisiana Experiment Station in 1893. A poor yield was reported. Not now grown.

Franklin. Big-Boll Group.

A late, long-jointed cotton formerly grown extensively in Chilton County, Ala., but now replaced by Russell.

Fuller's Improved. Big-Boll Group.

Georgia: Jackson and Walton counties.

A local variety developed by G. W. Fuller, of Winder, Ga. Not tested.

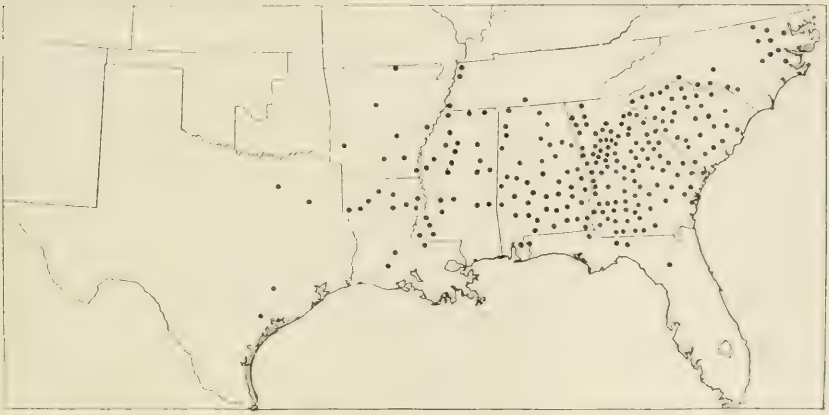

Fig. 25.—Map of the cotton-growing States, showing the distribution of Floradora cotton in cultivation, as reported in 1907.

Gardner. Big-Boll Group.

Reported only from St. Clair County, Ala. Not tested.

Garrard. Early Group.

(Also known as Garrard's Improved Prolific.)

Alabama Bulletins 130, 140. Georgia Bulletin 63. Mississippi Bulletin 84; Seventeenth Annual Report.

Developed from the Dickson and New Era cottons by P. R. and W. T. Garrard, Nona, Ga.

Plants of medium height, limbs usually 2 in number, light; branches slender, short jointed, with little or no tendency to semicluster; leaves medium to small; bolls small; lint rather short; seeds small, covered with a short, brownish gray fuzz. The following measurements were obtained from samples grown in Waco, Tex., and Timmonsville, S. C.

Bolls per pound, 89; seeds per pound, 4,300; average length of lint, 22 mm. ($\frac{7}{8}$ inch); strength of single fibers, 7.1 gms.; per cent of lint, Texas 37, South Carolina 34.

Gatlin, or Gatlin's Improved.

A local variety grown in Jasper and Wayne counties, Miss. Not tested.

Gayoso Prolific. Early Group.

(Also known as Early Gayoso and Green's Gayoso.)

Alabama Bulletin 140. Mississippi Bulletins 83, 84, 88; Fifteenth and Seventeenth Annual Reports.

Reported only from Jefferson County, Miss. A local variety developed by James P. and R. A. Green, Gayoso Plantation, Church Hill, Miss. It is claimed by the originators that this cotton is very prolific, the lint of superior length and strength, and the seeds smaller than those of any other variety on the market. A sample sent by the originators measured as follows:

Bolls per pound, 82½; seeds per pound, 4,750; average length of lint, 24.4 mm. ($\frac{15}{16}$ inch), varying from 21 to 28 mm.; strength of single fibers, 5.2 gms.; per cent of lint, 33.9.

Geohagan. Upland Long-Staple Group.

Reported from Catahoula Parish, La. It is said to have been brought from Mississippi by a Mr. Geohagan.

Georgia Big-Boll.

Reported from Comal, Tex. Not tested.

Georgia Breakdown.

Louisiana: East Feliciana Parish.

Originator unknown. It is said to have been introduced into Louisiana about eighteen years ago from Dekalb County, Ga. It was at that time a strain of Peterkin cotton, but has become mixed with long-staple varieties and now does not belong to any particular group.

Plants slender in growth, with 1 to 3 light limbs and long, slender fruiting branches. The fruiting branches often fork at about half their length, one fork becoming a sterile limb, the other remaining a fruiting branch; leaves rather small; bolls small and numerous, the majority 4-locked; lint of medium length; seeds covered with a sparse, short fuzz, grayish brown.

Bolls per pound, 87; seeds per pound, 5,040; average length of lint, 28 mm. ($1\frac{3}{32}$ inches); strength of single fibers, 7.2 gms.; per cent of lint, 32.

Georgia King.

Reported from Crockett and Dyer counties, Tenn. Not tested.

Georgia Long-Lint.

Reported from Bradley, Tenn. Not tested.

Georgia Prolific.

Arkansas Third Annual Report. Mississippi Second and Third Annual Reports. South Carolina Second Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Reported from Bibb County, Ga., Saline County, Ark., and Williamson County, Tex. Not tested.

Georgia Standard.

Georgia Bulletin 35.

Not now grown. Tested a number of years ago by the Georgia station.

Georgia's Best. Big-Boll Group.

Georgia Bulletin 79.

A variety tested by the Georgia Experiment Station in 1907. Closely related to Cook's Improved. Plants semicluster in habit; bolls medium to large, 57 per cent 5-locked; lint short, percentage high; seeds medium in size, fuzzy, brownish gray.

Bolls per pound, 67½, seeds per pound, 4,280, average length of lint, 20.7 mm. ($\frac{13}{16}$ inch), varying from 17 to 23 mm., strength of single fibers, 6.6 gms., per cent of lint, 39.7.

Gholson. Upland Long-Staple Group.

Alabama Bulletin 140.

See Golson.

Gibson. BIG-BOLL STORMPROOF GROUP.

Texas: Denton, Henderson, Kaufman, Rockwell, and Van Zandt counties.

A strain of stormproof cotton, very similar to Rowden, developed at Stone Point, Tex., by B. F. Gibson, now of Duncan, Okla.

Gilbert Lamb's-Wool.

Georgia Bulletin 35. Texas Bulletin 50.

Originated by J. M. Gilbert, Washington, Ga. Not now grown.

Gilcrease. BIG-BOLL GROUP.

Reported from Lauderdale County, Miss. Not tested.

Globe.

Formerly grown in Carroll County, Ga. Not now in cultivation.

Gold-Band.

A local variety grown in Edgefield County, S. C. Not tested.

Gold-Dust. EARLY GROUP.

Alabama Bulletins 33, 34, 40, 56, 107, 140. Louisiana Bulletin 62. South Carolina Bulletin 18; Second Annual Report. Texas Bulletin 40. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

See Tennessee Green-Seed.

Gold-Leaf. BIG-BOLL GROUP.

A local variety grown in Oglethorpe County, Ga., introduced more than twenty years ago and now badly mixed with other varieties. The leaves turn a golden green late in the season; plant large, branches medium to long jointed: bolls large, about 40 to the pound; per cent of lint, about 33.

Gold-Standard. PETERKIN GROUP.

Texas: Comanche, Erath, and Hood counties.

Alabama Bulletins 130, 140. Georgia Bulletin 79.

A strain of Texas Wood or Peterkin developed by C. F. Moore, Excelsior Seed Farm, Bennettsville, S. C. Plants similar to Peterkin, except that there is a small proportion of semiclustered plants; bolls small, 48 per cent 5-locked; lint of medium length; seeds small, mostly fuzzy, brown or yellowish brown, some entirely smooth and black.

The following measurements were taken from a sample grown at the Georgia Experiment Station in 1907:

Bolls per pound, 92; seeds per pound, 5,380, average length of lint, 22.3 mm. ($\frac{7}{8}$ inch), varying from 20 to 24 mm., strength of single fibers, 5.8 gms.; per cent of lint, 39.6.

Golden Prolific. PETERKIN GROUP.

Reported only from Dallas County, Ark. The percentage of lint is stated to be 36, the bolls small, cotton hard to pick, but a drought-resistant variety. Not tested.

Golson. UPLAND LONG-STAPLE GROUP.

Arkansas: Phillips County.

Georgia: Oglethorpe County.

South Carolina: Clarendon County.

Texas: Fayette and Harrison counties.

Alabama Bulletin 140 (as Gholson). Georgia Bulletin 59.

A strain of Allen Long-Staple developed by L. K. Golson, Fort Deposit, Ala. Plants tall and slender, with a much less semicluster habit of growth than Allen, otherwise very similar to it. Bolls small; lint very fine and silky and strong for a long-staple cotton; percentage rather low; seeds medium in size, fuzzy, gray.

Bolls per pound, 99; seeds per pound, 3,980; average length of lint, 34 mm. ($1\frac{1}{3}$ inches), varying from 32 to 36 mm.; strength of single fibers, 5 gms.; per cent of lint, 27.1.

Gondola.

See Dongola.

Goose-Egg. BIG-BOLL GROUP

Reported from Etowah and Madison counties, Ala. Not tested.

Graves.

Reported from Lonoke, Ark., Franklin, La., and Hinds, Miss. Not tested.

Grayson. BIG-BOLL GROUP.

Alabama Bulletins 107, 140. Louisiana Bulletins 27, old series; 8, 16, new series. Not now grown. Originated by W. B. Grayson, of Grayson, Ala.

Green-Seed.

See Tennessee Green-Seed.

Greer's Early. EARLY GROUP.

(Also known as Greer's Improved, Greer's King, and Grier.)

Alabama: Calhoun County.

Alabama Bulletins 130, 140. Georgia Bulletins 59, 63, 66, 70.

A strain of King selected for earliness by L. F. Greer, of Choccolocco, Ala. Plant similar to King. Bolls small to medium in size, 3 to 5 locked; seeds small, covered with short fuzz, brownish gray.

Bolls per pound, 73½; seeds per pound, 4,160; average length of lint, 24.2 mm. ($\frac{15}{16}$ inch), varying from 21 to 26 mm.; strength of single fibers, 6.5 gms.; per cent of lint, 35.3.

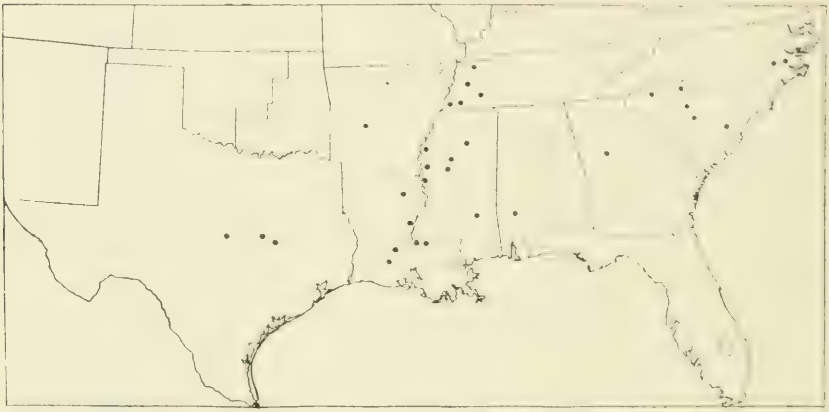

FIG. 26.—Map of the cotton-growing States, showing the distribution of Griffin cotton in cultivation, as reported in 1907.

Gregg's Improved. PETERKIN GROUP.

South Carolina: Florence County.

Alabama Bulletin 140.

Developed by selection from Gold-Standard by S. A. Gregg, Florence, S. C. Bolls medium in size; percentage of lint usually good.

Bolls per pound, 72; seeds per pound, 3,400; average length of lint, 24.2 mm. ($\frac{15}{16}$ inch), varying from 22 to 25 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 32 to 38.

Griffin. UPLAND LONG-STAPLE GROUP.

(Also known as Griffin Improved and Griffin Drought-Proof.)

Distribution: See map, figure 26.

Alabama Bulletins 89, 101, 107, 140. Georgia Bulletins 35, 52. Louisiana Bulletins 13, 21, 26, old series; 71 new series. Mississippi Bulletins 79, 83, 87, 88, 98. South Carolina Bulletin 1, old series; First and Second Annual reports. Texas Bulletin 50. Congressional Cotton Seed Distribution Leaflet for 1903. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A large-boll cotton originated by John Griffin at Refuge Plantation, near Greenville, Miss. The work of selection was begun in 1867 and was kept up until Mr. Griffin's death. His son, M. L. Griffin, of Greenville, Miss., has continued to improve the variety. Plant large and vigorous, with 1 to 3 limbs and medium-jointed fruiting branches, bolls large, lint long and silky but often weak, seeds of medium size, fuzzy, gray.

Bolls per pound, 62; seeds per pound, 4,000; average length of lint, 35.6 mm. ($1\frac{3}{8}$ inches), varying from 33 to 38 mm.; strength of single fibers, 5 gms.; per cent of lint, 29.7.

Grubbs Cluster. Semicluster Group.

Texas: Marion County.

Originator unknown. A variety bearing bolls of medium size, rounded in shape; per cent of lint about 36.

Gunn. Big-Boll Group.

Alabama Bulletins 107, 140. Louisiana Bulletins 22, 28. Mississippi Bulletin 18; Fourth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Originated by C. L. Gunn, Temple, Miss. Not now grown.

Gypsy. Peterkin Group.

Georgia: Jenkins County.

A local strain of Peterkin which is said to yield nearly 40 per cent of lint. Originator unknown.

Hackberry. Early Group.

Texas: Lynn County.

A local variety, probably a strain of Sugar-Loaf, or King. Not tested.

Hagaman.

Alabama: Bullock, Calhoun, Dallas, Sumter, and Wilcox counties.

Arkansas: Miller County.

Georgia: Houston and Spalding counties.

Louisiana: Acadia, Avoyelles, East Feliciana, Iberville, Livingston, Pointe Coupee, St. Helena, West Baton Rouge, and West Feliciana parishes.

Mississippi: Amite, Pearl River, Pike, and Wilkinson counties.

South Carolina. Edgefield County.

Tennessee: Giles and Hardeman counties.

Texas: Austin, Lipscomb, Karnes, Mason, and Medina counties.

Alabama Bulletins 138, 140. Louisiana Bulletins 7, 17, 22, 28, 62, 71. Congressional Cotton Seed Distribution Leaflets for 1905 and 1906.

Originated by Maj. F. V. D. Hagaman, Jackson, West Feliciana Parish, La., about 1877. Hagaman does not belong to any particular group, the lint being a little too short to be classed as a long-staple cotton.

Plant tall and pyramidal in shape, with 1 to 3 limbs and quite long, slender fruiting branches; joints of medium length, many plants having a tendency to put out small, sterile limbs alongside the fruiting branches, making the plant very leafy; leaves medium in size; bolls small, lint of good quality and length; seeds small, nearly smooth or sparsely fuzzy, with a tuft of brownish gray fuzz at one end.

Bolls per pound, 97; seeds per pound, 5,650; average length of lint, 27 mm. ($1\frac{1}{16}$ inches); strength of single fibers, 5.4 gms.; per cent of lint, 33.3.

Hale.

A local variety grown in Lee County, Arkansas. Not tested.

Hall. Peterkin Group.

(Also known as Peek cotton.)

A local variety quite popular in parts of Macon and Schley counties, Ga. It is a strain of Peterkin obtained by J. E. Hall, of Macon County, from the Atlanta Exposition, in 1881, and was introduced by Mr. Hall and a neighbor, John L. Peek, also of Macon County.

Hall.

Texas: Fannin and Hunt counties.

A strain of Texas cotton developed near Honey Grove, Tex., by D. T. Hall, now of Gadsonia, Tex.

Haralson. BIG-BOLL GROUP.

Alabama: Bullock County.

Georgia: Banks County.

Louisiana: West Feliciana Parish.

North Carolina: Johnston County.

Oklahoma: Roger Mills County.

Texas: Johnson County.

Alabama Bulletin 140. Georgia Bulletin 52.

Developed by H. C. Haralson, Social Circle, Ga. A large-boll cotton, quite similar to Dongola and probably derived from it. About 75 per cent of the plants are semicluster in habit, the remainder long branched. Plants of the former type are rather dwarf and stocky in growth, with 1 to 3 stout limbs or often none, their place being taken by fruiting branches; joints medium in length; leaves large; bolls large, percentage of lint good; seeds large, fuzzy, light brownish gray.

Bolls per pound, 51½; seeds per pound, 3,100; average length of lint, 23mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 5.6 gms.; per cent of lint, 35.

Hard-Shell. PETERKIN GROUP.

A cotton formerly grown in Henry County, Ala., and said to have been very resistant to blight and drought. It was taken to Alabama from one of the Eastern States by a Baptist minister before the war. Hard-Shell is the parent of Wood's Improved.

Hardin. SEMICLUSTER GROUP.

(Also known as Hardin's Prolific.)

Alabama: Lee, Marion, and Morgan counties.

Arkansas: Lafayette County.

Georgia: Baldwin, Bullock, Calhoun, Douglas, Emanuel, Jefferson, Lincoln, Marion, Newton, Pike, Putnam, Taliaferro, and Wilkes counties.

Louisiana: Concordia Parish.

South Carolina: Anderson, Colleton, Kershaw, Richland, and Saluda counties.

Tennessee: Henry County.

Alabama Bulletin 140. Georgia Bulletin 79.

Developed by B. B. Hardin, Washington, Wilkes County, Ga. This variety has been the subject of extravagant claims as to prolificacy, though the claims are to some extent true when the cotton is grown on very rich soil, the semicluster habit preventing the plants from becoming too "weedy." On poor or moderately good soil Hardin yields only an average crop.

Plant medium in size, limbs 1 to 4, fruiting branches short, joints short and irregular; bolls often clustered to some extent, bolls medium to small, 33 per cent 5-locked; lint medium to short, percentage good; seeds small, fuzzy, brownish gray.

The following measurements were obtained from a sample of Hardin grown at the Alabama station, at Auburn, Ala., in 1907:

Bolls per pound, 85½; seeds per pound, 4,720; average length of lint, 22.2 mm. ($\frac{7}{8}$ inch), varying from 19 to 25 mm.; strength of single fibers, 5 gms.; per cent of lint, 35.1.

Hardwick. BIG-BOLL GROUP.

Georgia Bulletin 75.

See Corput's Find.

Harper Improved.

Reported only from Nash County, N. C. Not tested.

Harris. UPLAND LONG-STAPLE GROUP.

Mississippi: Bolivar County.

A long-staple variety originally from Louisiana, developed by John and Lee Harris, of Beulah, Miss. Not tested.

Harris White-Seed.

Reported from Dunklin County, Mo. Not tested.

Hart's Improved. BIG-BOLL GROUP.

Georgia Bulletins 75, 79.

See Beat-All.

Harville. BIG-BOLL STORMPROOF GROUP.

(Also known as Tabor Big-Boll.)

Distribution: See map, figure 27.

Originated by H. T. Harville, Brownwood, Tex. A very distinct cotton, developed from a single plant found in his field cotton by Mr. Harville some years ago. It is said to be from 10 to 14 days later than Rowden in maturity. Plant large and vigorous in growth, with 1 to 3 limbs and fairly long fruiting branches below, shortening above, making the plant cone-shaped; stem and branches bright red; leaves very large, with shallow lobes, light green, almost yellowish green in color; bolls large, the majority 5-locked; lint medium in length, percentage good; seeds large, fuzzy, light brownish gray in color.

Bolls per pound, 52; seeds per pound, 3,370; average length of lint, 21.8 mm. ($\frac{7}{8}$ inch), varying from 20 to 23 mm.; strength of single fibers, 7.8 gms.; per cent of lint, 35.

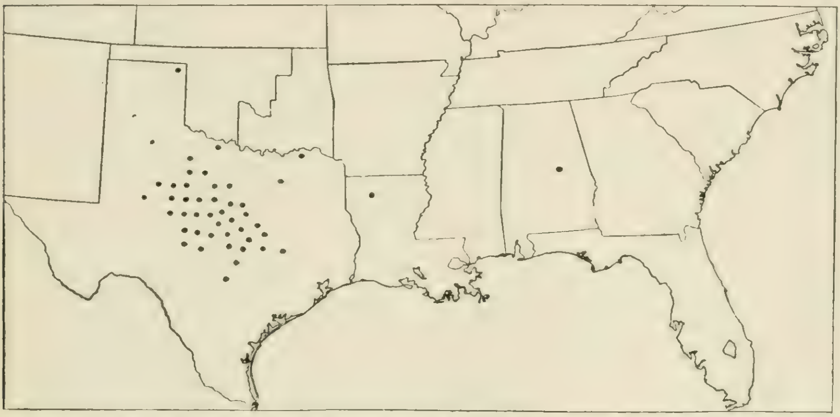

FIG. 27.—Map of the cotton-growing States, showing the distribution of Harville cotton in cultivation, as reported in 1907.

Hastey's Improved. BIG-BOLL GROUP.

Georgia: Campbell, Clarke, Harris, Meriwether, and Polk counties.

North Carolina: Anson County.

Georgia Bulletin 75.

Developed by R. L. Hastey, Chipley, Ga. Plant rather tall, limbs 1 to 3, fruiting branches long with little or no tendency to semicluster, joints rather long, leaves large, bolls large, percentage of lint good, seeds medium to large, fuzzy, light brownish gray.

Bolls per pound, 52; seeds per pound, 3,370; average length of lint, 23.2 mm. ($\frac{15}{16}$ inch), varying from 21 to 25 mm.; average strength, 7.3 gms.; per cent of lint, 35.1.

Hasting's Mortgage Lifter.

See Mortgage Lifter.

Hasting's Sure-Crop.

See Sure-Crop.

Hawkins Improved. SEMICLUSTER GROUP.

(Also known as Hawkins Extra-Prolific.)

Distribution: See map, figure 28.

Alabama Bulletins 5, 12, 13, 16, 33, 34, 40, 52, 56, 65, 76, 89, 101, 107, 130, 138, 140. Alabama (Canebrake) Bulletins 7, 11, 14. Arkansas Bulletin 18; First, Second, and Third Annual Reports. Georgia Bulletins 11, 20, 24, 43, 47. Louisiana Bulletins 21, 22, 26, 27, old series; 7, 8, 16, 17, 21, 22, 28, 29, 35, 47, 62, new series. Mississippi Bulletins 18, 84, 88, 98; Second, Third, Fourth, Fifteenth, and Seventeenth Annual Reports. Oklahoma Bulletin 23. South Carolina Bulletins 1, old series; 42, 120, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Congressional Cotton Seed Distribution Leaflet for 1906. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A well-known and standard variety developed by W. B. Hawkins, Nona, Ga., from a mixture of New Era, Peerless, Dickson, Herlong, and some others. Plants fairly early in maturity, tall and pyramidal in shape, with 1 to 3 limbs, fruiting branches numerous, short, and irregularly jointed, bolls clustered to some extent, leaves medium in size, bolls rather small to medium in size, lint rather short, percentage good, seeds small, fuzzy, light brownish gray.

Bolls per pound, 70; seeds per pound, 4,600; average length of lint, 22.6 mm. ($\frac{29}{32}$ inch), varying from 20 to 26 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 36.4.

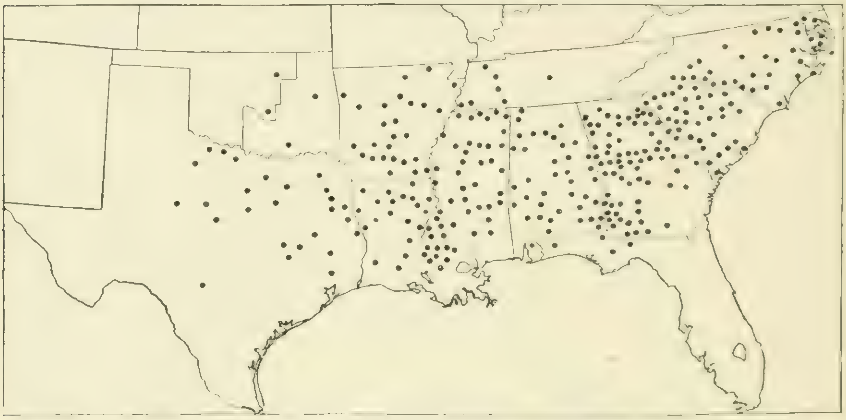

FIG. 28.—Map of the cotton-growing States, showing the distribution of Hawkins Improved cotton in cultivation, as reported in 1907.

Hawkins Jumbo.

Alabama Bulletins 107, 140. Georgia Bulletins 16, 27, 31. Mississippi Bulletin 62; Twelfth, Thirteenth, and Fifteenth Annual Reports.

Developed from Hawkins Improved by W. B. Hawkins, Nona, Ga. Not reported in 1907 and probably not now grown.

Hayden. BIG-BOLL GROUP.

Reported from Morehouse Parish, La. Originated by Geo. T. Hayden, Bastrop, La. Plant not seen, lint of medium length, seeds fuzzy, greenish or brownish gray.

Bolls per pound, 58; seeds per pound, 3,660; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 27 mm.; strength of single fibers, 7.3 gms.; per cent of lint, 32.5.

Haymore. BIG-BOLL GROUP.

Reported from Newton County, Ga. Originated by W. W. Haymore, Crawfordsville, Ga. Bolls medium to large, lint of good length, seeds of medium size, fuzzy, dark green or gray.

Bolls per pound, 67; seeds per pound, 3,800; average length of lint, 26 mm. (1 $\frac{1}{32}$ inches), varying from 21 to 29 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 33.5.

Haywood. UPLAND LONG-STAPLE GROUP.

Arkansas: Hempstead and Little River counties.

Developed by B. F. Haywood, Richmond, Ark. Quite similar to Allen Long-Staple. Plant tall, more or less semicluster in habit of growth, bolls small, lint fine and silky, seeds of medium size, fuzzy, brownish gray in color. The following measurements were taken from a sample grown in Waco, Tex.:

Bolls per pound, 116; seeds per pound, 4,190; average length of lint, 33.9 mm. ($1\frac{11}{32}$ inches), varying from 29 to 37 mm.; per cent of lint, 25.7.

Heinze Improved.

Reported from Bartow County, Ga. Originator unknown.

Henderson Big-Boll. BIG-BOLL GROUP.

Reported only from Denton County, Tex., and said to have been originated by C. Henderson, Pilot Point, Tex.

Herlong.

See Bancroft's Herlong.

Herndon, or Herndon Select. SEMICLUSTER GROUP.

Georgia: Elbert County.

Alabama Bulletins 107, 140. Georgia Bulletins 43, 47.

This variety is said to have been developed by J. A. Herndon, of Elberton, Ga. It was tested some years ago and was found to yield small bolls and seeds and a rather low percentage of lint.

Hiffley, or Hefley. BIG-BOLL GROUP.

Texas: Brazos, Callahan, and Falls counties.

Developed by J. D. Hiffley, of Cameron, Tex. Not tested.

Hilliard. EARLY GROUP.

Alabama Bulletins 107, 140. Mississippi Bulletin 18; Fourth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A small-bolled cotton developed by W. A. Hilliard, Bowersville, Ga. Not now grown.

Hillis, or Hillis Green-Seed. BIG-BOLL GROUP.

Texas: Clay and Rockwell counties.

Hillis is said to have been developed in Collin County, Tex., by selection from Rowden. It is an early, large-bolled cotton, yielding a good percentage of lint.

Hipp Improved.

(Also known as Hepp Improved.)

Georgia: Campbell and Meriwether counties.

Georgia Bulletin 75.

A local variety developed by T. A. Hipp, Forest, Ga., and tested by the Georgia station in 1906. As grown at the station this variety was not uniform, being a mixture of semiclustered and long-branched plants, bearing rather small bolls, mostly 4-locked. The following measurements were obtained:

Bolls per pound, 89; seeds per pound, 5,000; per cent of lint, 32.9.

Hodge. EARLY GROUP.

Alabama Bulletin 140. North Carolina State Board of Agriculture Bulletin for September, 1906.

Not now grown. It is said to have been similar to King.

Hodges. UPLAND LONG-STAPLE GROUP.

Not now grown. A long-staple variety which was tested several years ago by the Department of Agriculture. Bolls rather small, lint soft and fine, but very weak; seeds fuzzy, gray.

Bolls per pound, 84; seeds per pound, 3,475; average length of lint, 34 mm. ($1\frac{11}{32}$ inches); strength of single fibers, 2.8 gms.; per cent of lint, 25.

Hoelscher Big-Boll. BIG-BOLL GROUP.

Texas: Falls County.

Originated by B. P. Hoelscher, Lott, Tex. Plant not seen, lint of medium length, seeds large, fuzzy, light brownish gray.

Bolls per pound, $50\frac{1}{2}$; seeds per pound, 3,900; average length of lint, 24.5 mm. ($\frac{31}{32}$ inch), varying from 22 to 27 mm.; strength of single fibers, 8.2 gms.; per cent of lint, 34.2.

Hogan.

Reports of the Patent Office for 1848 and 1850. Report of the Commissioner of Agriculture for 1866.

An old variety not now grown.

Holmes. BIG-BOLL GROUP.

Alabama: Blount and Talladega counties.

Georgia: Dekalb, Lowndes, and Meriwether counties.

Louisiana: Winn Parish.

Mississippi: Kemper and Noxubee counties.

Texas: Bexar, Comal, Duval, Fannin, Fayette, Gonzales, and Karnes counties.

Louisiana Bulletin 62.

Said to have been developed by John Holmes, a negro living in Winn Parish, La. Not tested.

Holmes. UPLAND LONG-STAPLE GROUP.

Formerly grown in De Soto Parish, La. Lint soft and silky, 33 mm. ($1\frac{5}{16}$ inches) in length, seeds small, fuzzy, gray.

Howell. PETERKIN GROUP.

Louisiana Bulletin 17. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A local variety grown in Winn Parish, La., and said to have been introduced by Henry Howell, of Winfield, La. Not tested.

Hudson.

Reported from Rusk County, Tex. Not tested.

Huebner. BIG-BOLL STORMPROOF GROUP.

Texas: Austin, Falls, and Lavaca counties.

Originator unknown. An old variety, introduced about 1892, and probably a strain of Myers, which it greatly resembles. Not tested.

Humphrey's Dalkeith. UPLAND LONG-STAPLE GROUP.

Texas Bulletin 50.

See Keno.

Hunnicutt. BIG-BOLL GROUP.

(Also known as Hunnicutt Choice and Hunnicutt Big-Boll.)

Alabama Bulletins 33, 34, 40, 56, 76, 89, 107, 140. Georgia Bulletins 11, 16, 20, 24, 27, 31. Louisiana Bulletins 21, 22, 28, 29. Mississippi Bulletin 18; Fourth Annual Report. Oklahoma Bulletin 23. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. A large-boll, late variety developed by J. B. Hunnicutt, of Athens, Ga.

Hunnicutt Big-Boll. BIG-BOLL GROUP.

Alabama: Sumter County.

A local variety developed by J. A. Hunnicutt, of Livingston, Ala.

Hurley Improved Gold-Dust.

Louisiana Bulletin 47.

Not now grown.

Hurley's Choice Long-Staple.

Louisiana Bulletin 62. Texas Bulletins 34, 40, 45, 50.

Not now grown.

Hutchinson. BIG-BOLL GROUP.

(Also known as Hutchinson's Improved Prolific and Hutchinson's Stormproof Prolific.)

Alabama: Lee County.

Georgia: Coweta and Meriwether counties.

North Carolina: Mecklenburg County.

South Carolina: Beaufort County.

Tennessee: Gibson County.

Alabama Bulletins 76, 89, 101, 140. Georgia Bulletins 31, 35, 39, 56. Louisiana Bulletin 47. South Carolina Bulletins 42, 120.

Originated by J. N. Hutchinson, Salem, Ala. Formerly grown more extensively than at present. As tested by the experiment stations, Hutchinson yielded 55 to 60 bolls per pound, 3,100 to 3,500 seeds per pound, and 31 to 32 per cent of lint.

Immanuel. EARLY GROUP.

Reported from Sumter County, S. C. A small-boll, short-staple variety yielding about 34 per cent of lint. Not tested.

Imperial Big-Boll.

Tested by the Louisiana station at Baton Rouge in 1907. Classification uncertain, as the bolls are too small to be included in the big-boll group.

Bolls per pound, 81; seeds per pound, 3,870; average length of lint, 22.3 mm. ($\frac{29}{32}$ inch), varying from 20 to 27 mm.; per cent of lint, 31.8.

Irene.

Reported from East Feliciana Parish, La.

See Peebles Choice, formerly known as Peebles Irene.

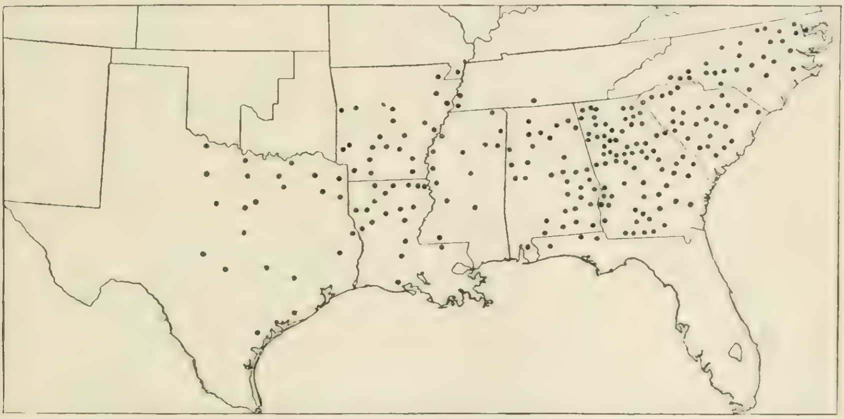

FIG. 29.—Map of the cotton-growing States, showing the distribution of Jackson, or African Limbless, cotton in cultivation, as reported in 1907.

Jackson, or African Limbless. CLUSTER GROUP.

Distribution: See map, figure 29.

Alabama Bulletins 101, 107, 130, 138, 140. Georgia Bulletins 39, 43, 47. Louisiana Bulletin 62. Mississippi Bulletin 62; Thirteenth and Fifteenth Annual Reports. South Carolina Bulletins 42, 120.

A closely clustered variety introduced in 1894 by T. W. Jackson, of Atlanta, Ga. Most extravagant claims were made for this variety and for a time seed was sold at a very high price. It was similar to Dickson and Welborn's Pet, but grew taller and the leaves were somewhat larger. It is rarely seen now in a pure state and is grown much less than formerly. Like other cluster cottons, Jackson is very prolific on rich soils where long-limb varieties are too "weedy" in growth.

Plant tall and slender, limbs 1 to 3; fruiting branches reduced to spurs from 1 to 6 inches long; leaves very large; bolls crowded together on the shortened branches, 4 to 5 locked, rounded in shape; lint of medium length; seeds medium in size, fuzzy, brownish gray; cotton very hard to pick free from trash.

Bolls per pound, 98; seeds per pound, 4,530; average length of lint, 22 mm. ($\frac{7}{8}$ inch); strength of single fibers, 5.2 gms.; per cent of lint, 34.5.

Jackson Round-Boll. BIG-BOLL STORMPROOF GROUP.

(Also known as Apple-Boll.)

Distribution: See map, figure 30.

Congressional Cotton Seed Distribution Leaflet for 1906.

Originated by James Jackson, Preston, Tex., from a single plant found in his field in 1897. Bolls round; burs without sharp points, easily picked but stormproof; plant large and vigorous, with 1 to 3 limbs; fruiting branches fairly short jointed; leaves large; bolls large, the majority 5-locked; lint of medium length; percentage good; seeds large, fuzzy, gray.

Bolls per pound, 53½; seeds per pound, 3,380; average length of lint, 23 mm. ([illegible] inch), varying from 21 to 24 mm.; strength of single fibers, 7.6 gms.; per cent of lint, 35.8.

Japan. BIG-BOLL GROUP.

Alabama Bulletins 107, 140. Texas Bulletin 40.

An old variety not now in cultivation.

Java.

This variety was formerly grown in White County, Ark. It is stated that Dr. J. J. Goodloe and E. H. Blankenship, of Rose Bud, Ark., introduced it in 1870.

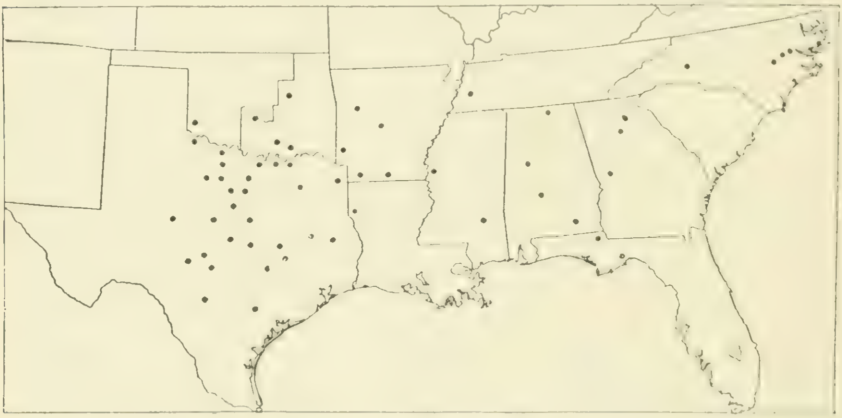

FIG. 30.—Map of the cotton-growing States, showing the distribution of Jackson Round-Boll cotton in cultivation, as reported in 1907.

Jersey. PETERKIN GROUP.

(Also known as Jersey Little Brown-Seed.)

A strain of Peterkin grown in Jefferson Davis County, Miss., and said to yield 38 to 40 per cent of lint. Originator unknown. Not tested.

John Bull. UPLAND LONG-STAPLE GROUP.

Mississippi Bulletin 88.

Formerly grown in Pike County, Miss. Tested in 1904 by the Mississippi station. Per cent of lint, 29.3; length, 1½ inches.

Johnson's Big-Boll. BIG-BOLL GROUP.

Reported from Woodford, Okla., and probably the same as Harville. Not tested.

Johnson's Improved. SEMICLUSTER GROUP.

Distribution: See map, figure 31.

Alabama Bulletin 140.

A variety introduced by the Mark W. Johnson Seed Company, Atlanta, Ga. Plants not uniform, mostly semicluster in habit of growth, but with a considerable mixture of longer branched cotton; bolls small to medium in size, seeds fuzzy, brownish gray.

Jones Early. EARLY GROUP.

Texas: Bosque and Brazos counties.

This variety was developed many years ago by a Doctor Jones, of Bryan, Tex., from a mixture of Herlong and Bohemian. It was selected for earliness and percentage of lint. Doctor Jones is now dead, but his former neighbor, J. H. White, continued to improve the variety.

Plants of medium height, limbs 1 to 3: fruiting branches slender, short, but regularly jointed; leaves medium in size; bolls rather small to medium; percentage of lint good; seeds fuzzy, greenish or brownish gray.

Bolls per pound, 79½; seeds per pound, 4,430; average length of lint, 25.1 mm. ($\frac{31}{32}$ inch), varying from 23 to 29 mm.; strength of single fibers, 6.9 gms.; per cent of lint, 36.

Jones Improved. BIG-BOLL GROUP.

Distribution: See map, figure 32.

Alabama Bulletins 5, 12, 13, 16, 33, 40, 56, 76, 89, 101, 107, 130, 140; Report for 1881-82. Alabama (Canebrake) Bulletins 7, 11, 14. Arkansas Bulletin 18; First and Third Annual Reports. Georgia Bulletins 16, 20, 24, 27, 31, 35, 39, 43, 52, 56, 59, 63, 70. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 8, 16, 62, new series. Mississippi Bulletins 62, 83, 87, 98; Third, Twelfth, and Thirteenth Annual Reports. South Carolina Bulletins 1, old series; 120, new series; First and Second Annual Reports. Texas Bulletins 40, 45, 50. Congressional Cotton Seed Distribution Leaflet for 1903. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

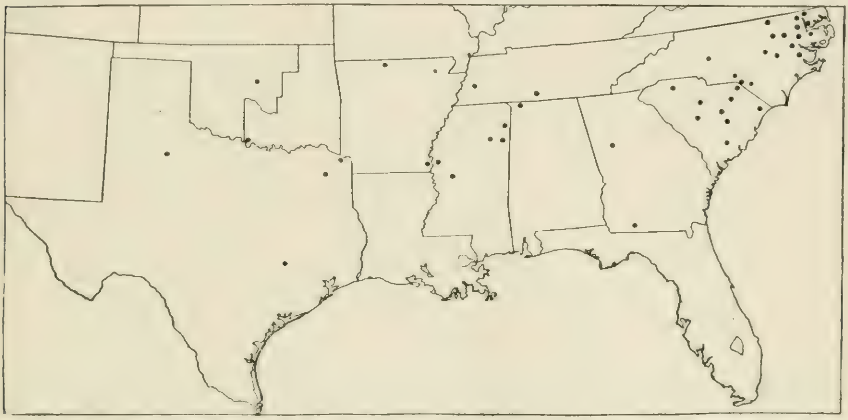

FIG. 31.—Map of the cotton-growing States, showing the distribution of Johnson's Improved cotton in cultivation, as reported in 1907.

J. F. Jones, of Hogansville, Ga., states that he obtained the seed of this variety from the field of J. S. Wyche, of Oakland, Ga., many years ago. Jones Improved is now slightly different from Wyche, the bolls being smaller and the plants earlier in maturity. It has become somewhat mixed with other varieties during the past few years.

Plants of medium height, stocky in growth, with 1 to 3, usually 2, stout limbs; fruiting branches 2 feet or more in length at base of stalk, 4 to 8 inches at the top; joints rather long, especially the first; leaves large; bolls large, the majority 5-locked; lint of medium length; seeds large, fuzzy, gray.

Bolls per pound, 60; seeds per pound, 3,050; average length of lint, 24 mm. ($\frac{15}{16}$ inch); strength of single fibers, 5.2 gms.; per cent of lint, 30.

Jones Wonderful. UPLAND LONG-STAPLE GROUP.

(Also known as Jones Long-Staple Prolific.)

Distribution: See map, figure 33.

Alabama Bulletins 33, 40, 52, 56, 76, 107, 140. Arkansas Bulletin 18. Georgia Bulletins 11, 20, 24, 27, 31. Louisiana Bulletin 16. Mississippi Bulletins 18, 23, 62; Second, Third, Fourth, Sixth, and Eighth Annual Reports. South Carolina

Bulletin 1, old series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. It was developed by J. H. Jones, Herndon, Ga. As tested by the experiment stations from ten to fifteen years ago, this variety was a long-staple cotton yielding lint 1⅛ to 1 5/16 inches in length; per cent, 28 to 30.

Joslin Improved.

A local variety grown in Delta County, Tex. Not tested.

Jowers, or Jowers Improved.

Alabama Bulletin 76; Report for 1881–82. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 8, 16, new series. South Carolina Bulletin 1, old series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Reported from Lee, Terrell, and Webster counties, Ga. Originated by W. P. Jowers, Preston, Ga. Jowers was tested twenty years ago by the Louisiana Agricultural Experiment Station, with the following results:

Bolls per pound, 85; seeds per pound, 4,300; per cent of lint, 34.4.

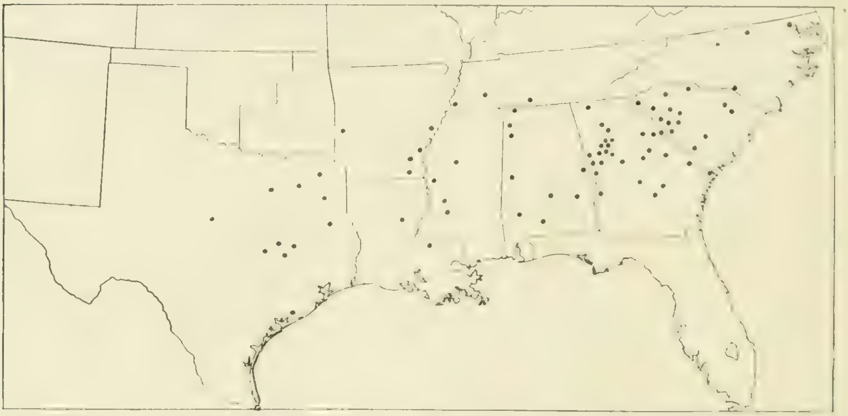

FIG. 32.—Map of the cotton-growing States, showing the distribution of Jones Improved cotton in cultivation, as reported in 1907.

Jumbo. BIG-BOLL GROUP.

Reported from Montgomery County, Kans., and said to have been brought from Texas.

Keith. SEMICLUSTER GROUP.

Alabama Bulletins 33, 34, 40, 56, 107, 140. Georgia Bulletins 11, 16. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A local variety not now grown. It is stated to have been an early-maturing cotton with short-jointed fruiting branches. Per cent of lint, 30 to 31; length of lint, 1 inch.

Kelly. CLUSTER GROUP.

Arkansas: Conway County.

North Carolina: Gaston and Pitt counties.

Louisiana Bulletins 22, 28. Mississippi Bulletin 18; Fourth Annual Report.

A cluster cotton very similar to Dickson. It was developed by selection from Herlong, by S. E. Kelly, Appling, Ga.

Plant spire shaped, tall, with 1 to 3 limbs and very short fruiting branches, 4 to 8 inches long below, shortening to 1 to 2 inches at the top of the plant; leaves medium to large; bolls medium in size, rounded; seeds rather small, fuzzy, greenish or brownish gray.

Bolls per pound, 87; seeds per pound, 5,050; average length of lint, 20 mm. (25/32 inch); per cent of lint, 31.

Kemp. Semicluster Group.

Louisiana: Vernon Parish.

Originator unknown. Plant short branched, medium early in maturity; bolls medium in size, opening widely and allowing the cotton to waste badly during storms; seeds small, fuzzy, gray; per cent of lint, 33 to 35. Not tested.

Kemper County.

Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports.

A local variety from Moscow, Miss., tested by the Mississippi station in 1905. The length of lint is stated to be 1 inch, the per cent, 33.3.

Kenneth. Upland Long-Staple Group.

Louisiana Bulletins 21, 29.

A local variety from Monroe, La., tested by the Louisiana station in 1893. The percentage is given as 29.4.

Keno. Upland Long-Staple Group.

(Also known as Keyno, Atkins, Adkin, Mand Adkin, Eureka, Colthorp, Colthorp Eureka, Dalkeith, Dalkeith Eureka, and Humphrey Eureka.)

Alabama: Chilton, Jefferson, Marion, and Tuscaloosa counties.

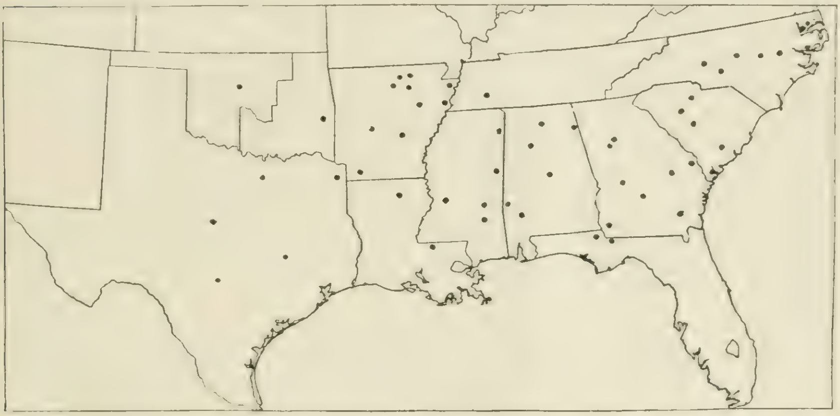

Fig. 33.—Map of the cotton-growing States, showing the distribution of Jones Wonderful cotton in cultivation, as reported in 1907.

Arkansas: Chicot, Hempstead, Lafayette, Monroe, and Phillips counties.

Louisiana: Acadia, Concordia, East Carroll, Iberville, Madison, Pointe Coupee, Tensas, West Feliciana, and Winn parishes.

Mississippi: Grenada, Issaquena, Quitman, Tallahatchie, and Washington counties.

North Carolina: Chowan, Cleveland, Edgecombe, Jones, and Rutherford counties.

South Carolina: Lexington County.

Tennessee: Chester County.

Texas: Camp, Comanche, Hunt, and Liberty counties.

Alabama Bulletins 40, 52, 107, 140. Louisiana Bulletins 16, 17, 21, 22, 28, 29, 35. Mississippi Bulletins 18, 23, 62; Fourth, Sixth, and Eighth Annual Reports. South Carolina Bulletins 1, old series; 2, 18, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A "quarter" cotton originated many years ago by a negro, Mand Adkin, who was then living at Omega, La., and sold by him to A. S. Colthorp, Talla Bena, Madison Parish, La. Keno was originated by a three years' selection of the best plants in a 50-acre field of common cotton. Nothing has since been done to improve the variety, but the seed has been kept pure by Mr. Colthorp and other planters of Madison Parish.

Plant tall and slender, pyramidal, open in growth or in some soils semiclustered; limbs 0 to 3, coming out 6 to 8 inches from the ground; fruiting branches long, slender, and fairly short jointed; bolls rather small, pointed; lint soft, fine, and silky; seeds rather small, fuzzy, and gray in color, a small percentage smooth and black.

A sample grown by Mr. Colthorp in 1907 measured as follows:

Bolls per pound, 92; seeds per pound, 4,220; average length of lint, 29.5 mm. ($1\frac{5}{32}$ inches), varying from 27 to 32 mm.; strength of single fibers, 5.5 gms.; per cent of lint, 28.3.

Kikoka, or Kioka. PETERKIN GROUP.

Georgia: Houston and Pulaski counties.

Georgia Bulletin 75.

Developed by W. B. Sparks, of Macon, Ga. Plant rather tall and slender in growth, limbs 1 to 3; fruiting branches long and slender, joints of medium length; bolls small to medium in size; percentage of lint high, from 38 to 39.

Kimble. PETERKIN GROUP.

A local variety formerly grown in Webster Parish, La.

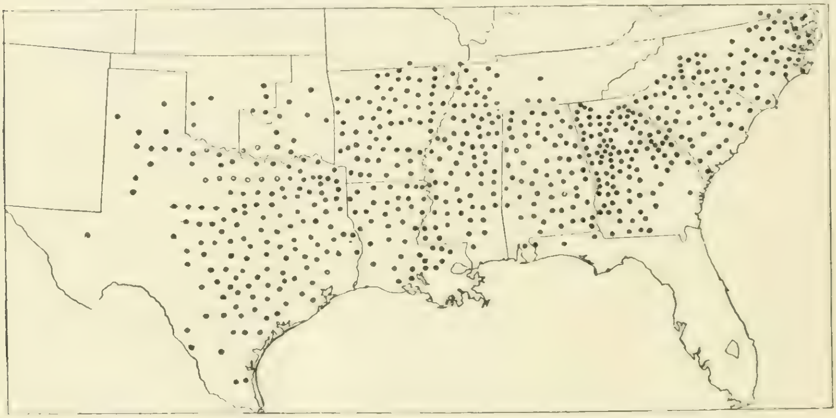

FIG. 34.—Map of the cotton-growing States, showing the distribution of King, or King's Improved, cotton in cultivation, as reported in 1907.

King, or King's Improved. EARLY GROUP.

Distribution: See map, figure 34.

Alabama Bulletins 5, 12, 13, 16, 22, 33, 34, 40, 56, 76, 101, 107, 130, 138, 140. Alabama (Canebrake) Bulletins 7, 11, 14, 22, 23. Alabama (Tuskegee) Bulletin 7. Alabama (Wetumpka) First Annual Report. Georgia Bulletins 11, 16, 20, 24, 27, 31, 35, 39, 43, 47, 63, 66, 70. Louisiana Bulletins 21, 22, 26, 27, old series; 7, 16, 17, 22, 29, 35, 47, 62, 71, new series. Mississippi Bulletins 18, 23, 62, 79, 83, 84, 87, 88, 98; Third, Fourth, Sixth, Eighth, Twelfth, Thirteenth, and Seventeenth Annual Reports. North Carolina Bulletin 146. North Carolina State Board of Agriculture Bulletin for September, 1906. Oklahoma Bulletin 23. South Carolina Bulletins 18, 42, 120. Texas Bulletins 34, 40, 45, 50, 75. Congressional Cotton Seed Distribution Leaflets for 1903 and 1904. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

T. J. King, formerly of Louisburg, N. C., now of Richmond, Va., states that about 1890 he found a stalk of very prolific cotton in his field of Sugar-Loaf. The seed from this stalk was saved separately, and from it he developed the strain known as King's Improved. Some years afterwards he sent seed of this strain, together with Sugar-Loaf, to several experiment stations under the names "King's Improved No. 1" and "King's Improved No. 2." Mr King became convinced from the reports so obtained that his strain had become practically identical with the parent variety, Sugar-Loaf, and in this publication they are considered as one variety. See Sugar-Loaf for description of plant, etc.

King's Green-Seed.

Reported only from Pike County, Ark. Not tested.

Kirk. UPLAND LONG-STAPLE GROUP.

Mississippi: Bolivar, Coahoma, and Grenada counties.

Developed by J. M. Kirk, Gunnison, Miss., who states that this variety is the result of several years' careful selection of a long-staple cotton purchased from Mr. Craig, of Vicksburg. Seeds small; lint soft and fine, $1\frac{1}{2}$ inches in length.

Kirkwood. BIG-BOLL GROUP.

South Carolina: Spartanburg and York counties.

A large-boll cotton resembling Truitt. Originator unknown. Not tested.

Knight.

(Also known as Knight's Improved Small-Seed Prolific.)

Georgia Bulletins 27, 31.

Developed by W. G. Knight, Sandersville, Ga. Not now grown. This variety was tested by the Georgia Experiment Station in 1894–95, with the following results:

Bolls per pound, 78 to 98; seeds per pound, 4,166 to 5,263; per cent of lint, 33 to 34.

Knox. SEMICLUSTER GROUP.

A local variety grown in Montgomery County, Ark. It is said to have been developed by a Mr. Knox, of Crystal Springs, Ark.

Kolb's Prolific.

Alabama (Canebrake) Bulletin 18. Louisiana Bulletins 28, 29.

Not now grown. Tested by the Louisiana Experiment Station in 1894, when the percentage of lint was found to be from 34 to 35.

Laas. BIG-BOLL STORMPROOF GROUP.

Texas: Waller County.

Developed by H. Laas, R. F. D. No. 1, Brookshire, Tex., by crossing Bohemian and Russell. Lint of good length; seeds large, fuzzy, gray and green in color.

Bolls per pound, 44; seeds per pound, 3,260; average length of lint, 25.8 mm. ($1\frac{1}{32}$ inches), varying from 24 to 28 mm.; strength of single fibers, 6.6 gms.; per cent of lint, 35.2.

Laird.

Reported from Falls County, Tex. Originator unknown. Not tested.

Lamb's-Wool.

Not now in cultivation. It was formerly grown in Randolph County, Ala. Originator unknown.

Laney Improved. EARLY GROUP.

Developed by R. B. Laney, Cheraw, S. C. Not tested.

Langford, or Langford Big-Boll. BIG-BOLL GROUP.

Georgia: Madison County.

Alabama Bulletin 140. Georgia Bulletin 70.

Developed by Sidney J. Langford, Hix, Ga. Plants large and vigorous in growth, quite strongly semiclustered; limbs usually 2, fruiting branches short and irregularly jointed; bolls large, percentage of lint good; seeds rather large, fuzzy, gray or greenish gray.

Bolls per pound, 56; seeds per pound, 3,260; average length of lint, 25.5 mm. (1 inch), varying from 23 to 27 mm.; strength of single fibers, 6.5 gms.; per cent of lint, from 34 to 38.6.

Layton Improved. PETERKIN GROUP.

Arkansas: Jackson and Lee counties.

Georgia: Elbert, Floyd, Polk, Spalding, Sumter, and Talbot counties.

Mississippi: Amite County.

South Carolina: Greenwood, Lancaster, Newberry, and Orangeburg counties.

Texas: Blanco County.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 63, 66, 70, 75, 79. Mississippi Bulletin 98.

A strain of Peterkin developed by R. D. Layton, St. Matthews, S. C. Plant similar to Peterkin, bolls small to medium in size, 54 per cent 5-locked; lint rather short, percentage very high; seeds small, covered with a short, brownish gray fuzz.

Bolls per pound, 82; seeds per pound, 5,170; average length of lint, 23.1 mm. ($\frac{29}{32}$ inch), varying from 21 to 26 mm.; strength of single fibers, 6.1 gms.; per cent of lint, 39.9.

Leafless.

Texas: Throckmorton County.

See Rublee's Leafless.

Lealand. SEMICLUSTER GROUP.

Georgia: Oglethorpe County.

Alabama Bulletins 130, 140. Georgia Bulletins 59, 63.

A local variety developed by Henry P. Jones, of Herndon, Ga. Bolls per pound, 80 to 84; per cent of lint, from 28 to 32.

Lee. BIG-BOLL GROUP.

(Also known as Lee's Improved, Lee's Early, and Lee's No. 1 and No. 2.)

Alabama: Dallas County.

Georgia: Jenkins and Spalding counties.

North Carolina: Harnett and Rutherford counties.

Mississippi: Bolivar and Grenada counties.

Texas: Austin County.

Alabama Bulletins 107, 140. Georgia Bulletins 39, 43, 52, 59, 70. Mississippi Bulletin 62; Thirteenth and Fifteenth Annual Reports.

Developed by E. E. Lee, of Corinth, Ala., and said to be a "selection of the best of the old Cummings variety." Not tested.

Lewis Prize. SEMICLUSTER GROUP.

(Also known as Lewis Improved Prize Prolific.)

Alabama: Greene County.

Georgia: Elbert County.

Louisiana: Tangipahoa Parish.

Mississippi: Amite, Claibourne, Clay, Hinds, Holmes, Lauderdale, and Wilkinson counties.

North Carolina: Gaston and Johnson counties.

South Carolina: Barnwell County.

Alabama Bulletins 130, 140. Georgia Bulletins 66, 70, 75. Mississippi Bulletins 79, 84, 98; Fifteenth Annual Report.

Developed by W. B. F. Lewis, Lewiston, La. Plants lacking in uniformity, some closely semiclustered, others more open and long branched; bolls of medium size, rounded; seeds fuzzy, brown; lint of medium length, high in percentage.

Bolls per pound, 81; seeds per pound, 4,880; average length of lint, 24.1 mm. ($\frac{15}{16}$ inch), varying from 21 to 26 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 38.3.

Limbaugh Improved. BIG-BOLL GROUP.

Alabama: Talladega County.

Developed by W. J. Limbaugh, Sylacauga, Talladega County, Ala., by mixing Russell, King, and Cook's Improved.

Bolls per pound, 54; seeds per pound, 3,600; average length of lint, 21 mm. ($\frac{13}{16}$ inch), varying from 19 to 23 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 33.8.

Little Brannon. PETERKIN GROUP.

Louisiana: East Baton Rouge, Iberville, and Livingston parishes.

A small-boll selection from Brannon, grown by the Louisiana station (Baton Rouge) in 1907. Lint of good length; seeds of medium size, fuzzy.

Bolls per pound, 72 to 94; seeds per pound, 3,980; average length of lint, 27.3 mm. ($1\frac{1}{16}$ inches), varying from 25 to 29 mm.; strength of single fibers, 5 gms.; per cent of lint, 27 to 36.

Little Maxie. EARLY GROUP.

Arkansas: Stone County.

Originated by John H. Maxie, Timbo, Stone County, Ark. Not tested.

Little's Improved. CLUSTER GROUP.

Alabama Bulletin 140. Georgia Bulletin 47.

Not now grown. It was a strain of cluster cotton resembling Dickson, selected from Edgeworth by J. C. Little, Louisville, Ga.

Long-Shank, or Shankhigh. BIG-BOLL GROUP.

Georgia: Clarke and Oconee counties.

Alabama Bulletin 140. Georgia Bulletin 79.

Originated by R. E. and M. L. Branch, Bishop, Oconee County, Ga. A distinct variety characterized by the distance from the ground to the first limbs and by the rounded bolls.

Plant strongly semicluster or almost cluster in habit of growth; limbs 1 to 3, coming out 6 to 8 inches above the base; fruiting branches short with short and irregular joints; bolls medium to large, seeds large; fuzzy, gray in color.

Bolls per pound, 59½, seeds per pound, 3,450; average length of lint, 23.6 mm. (15/16 inch), varying from 22 to 25 mm.; strength of single fibers, 5.7 gms.; per cent of lint, 34.4.

Lowe. BIG-BOLL GROUP.

Mississippi: Lauderdale County.

A Texas big-boll variety introduced into Mississippi about sixteen years ago and improved by S. A. Lowe, of Meridian, Miss. Lint of fair length, strong; seeds large, fuzzy.

Bolls per pound, 46; seeds per pound, 3,360; average length of lint, 24.6 mm. (31/32 inch), varying from 23 to 26 mm.; strength of single fibers, 7.6 gms.; per cent of lint, 36.

Lowell. BIG-BOLL GROUP.

Texas: Glasscock and Hill counties.

Originator unknown. Said to be a large-boll variety earlier than Rowden. Not tested.

Lowry. EARLY GROUP.

(Also known as Lowry's Improved and Lowry's Purest Prolific.)

Alabama Bulletins 107, 140. Georgia Bulletins 31, 35. South Carolina Bulletins 42, 120. Texas Bulletin 50.

An early-maturing, small-boll variety developed by J. G. Lowry, Cartersville, Ga. Not now in cultivation.

McCall. CLUSTER GROUP.

South Carolina: Clarendon, Dorchester, Marlboro, Richland, and Saluda counties.

Alabama Bulletin 140. Georgia Bulletin 56. South Carolina Bulletins 1, old series; 2, new series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A cluster cotton resembling Dickson which was developed by a Mrs. McCall, of Bennettsville, S. C. The name "Triple-Jointed" has been proposed for this cotton on account of the bolls often being borne in clusters of three.

McCauley.

Texas: Titus County.

Originator unknown. Not tested.

McClendon. BIG-BOLL GROUP.

Georgia: Haralson County.

Said to be a large-boll variety yielding from 34 to 36 per cent of lint. Originator unknown. Not tested.

McClure's Prolific.

Texas: Smith County.

Originator unknown. Not tested.

McCrary Prolific.

South Carolina: Anderson County.

Developed by Samuel McCrary, Autun, S. C. Not tested.

McLain Prolific. EARLY GROUP.

Louisiana: Caldwell and Franklin parishes.

A small to medium boll cotton grown locally. It is said to yield 37.5 per cent of lint. Originator unknown. Not tested.

Maddox, or Maddox Improved. BIG-BOLL GROUP.

Alabama Bulletins 107, 140. Georgia Bulletin 43.

Not now grown. A late-maturing, large-boll variety developed by J. S. Maddox, of Orchard Hill, Ga.

Mallius Prolific.

Louisiana Bulletin 13, old series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. A local variety grown in Louisiana about twenty years ago.

Mameluke.

Louisiana: Richland Parish.

Said to have been introduced recently by David Todd, of Natchez, Miss. Not tested.

Mammoth Prolific. BIG-BOLL GROUP.

Arkansas Bulletins 18, 23; Third Annual Report. Georgia Bulletins 11, 20. Mississippi Bulletin No. 18; Second, Third, and Fourth Annual Reports. North Carolina Tenth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. A variety resembling Truitt, developed by T. J. King, of Louisburg, N. C.

Marshall.

A local variety grown in Rankin County, Miss. Not tested.

Marston, or Marston's Prolific. UPLAND LONG-STAPLE GROUP.

Louisiana Bulletins 21, 22, 28, 29; Third and Fourth Annual Reports. Mississippi Bulletins 18, 23; Fourth Annual Report. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. Developed by S. W. Marston, East Point, La.

Martin Five-Lock. BIG-BOLL GROUP.

A large-boll variety grown quite extensively at Newport, Lone Grove, and Keller, Okla., and said to have been originated about six years ago by Peter Martin, of Healdton, Okla. Not tested.

Martin Prolific.

Louisiana Bulletins 21, 22, 26, 27, old series; 8, 16, new series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. A local variety tested some years ago by the Louisiana station. The percentage of lint is given as 30.

Maryland Green-Seed. EARLY GROUP.

An unimproved cotton grown in some parts of Maryland where home spinning still survives. It is quite a distinct variety and related to Tennessee Green-Seed, but more dwarf in habit of growth. It is slightly earlier than King.

Plant dwarf and spreading in habit, 2 to 3 feet high, limbs short; fruiting branches short jointed, leaves small to medium in size, softly hairy; flowers creamy white without petal spots; bolls 3, 4, and 5 locked, cotton falling out badly during storms; lint short; percentage low; seeds rather large, fuzzy, green.

Bolls per pound, 105; seeds per pound, 3,750; average length of lint, 20 mm. ($\frac{25}{32}$ inch); strength of single fibers, 6.9 gms.; per cent of lint, 25.

Mascot. EARLY GROUP.

Georgia: Bullock and Spalding counties.

Louisiana: Bienville Parish.

South Carolina: Clarendon and Lancaster counties.

Alabama Bulletins 130, 140. Georgia Bulletins 39, 43, 47, 56, 63, 66. Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports.

A strain of King developed by J. G. Ruan, Macon, Ga. It was tested several times by experiment stations, and the results show that the bolls are slightly larger than those of King.

Mask's Green-Leaf. BIG-BOLL GROUP.

Alabama: Tuscaloosa County.

Georgia: Fayette County.

North Carolina: Carteret County.

Tennessee: Decatur County.

Texas: Denton and Hunt counties.

Georgia Bulletins 75, 79.

Originated by T. H. Mask, Inman, Ga. Plant semicluster in habit of growth, fairly uniform, limbs 1 to 3; fruiting branches short and irregularly jointed; leaves large, smooth, and flat, and held later in the fall than those of other varieties; bolls large, 67 per cent 5-locked; lint of medium length, percentage of lint good; seeds of medium size, fuzzy, brownish gray.

Bolls per pound, 66½; seeds per pound, 4,060; average length of lint, 24.2 mm. 15/16 inch), varying from 22 to 26 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 37.

Mastodon.

Reports of Patent Office, 1847 and 1849.

An old variety not now grown.

Matagorda Silk.

A variety formerly grown in Shelby County, Tenn. Originator unknown.

Matthews. UPLAND LONG-STAPLE GROUP.

(Also known as Matthews's Extra-Long-Staple.)

Alabama: Jefferson County.

Arkansas: Clay, Hempstead, Pope, Phillips, and White counties.

Florida: Santa Rosa County.

Georgia: Bryan and Grady counties.

Louisiana: Catahoula Parish.

Mississippi: Tishomingo County.

Missouri: Dunklin County.

North Carolina: Catawba and Vance counties.

South Carolina: Oconee County.

Tennessee: Rutherford and Shelby counties.

Texas: Cass and Shelby counties.

Alabama Bulletins 40, 52, 107, 140. Georgia Bulletin 20. Louisiana Bulletins 21, 22, 28, 29. Mississippi Bulletin 23; Sixth Annual Report. North Carolina Bulletin 146. South Carolina Bulletin 18. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A variety developed by J. A. Matthews, Holly Springs, Miss. It was tested about fifteen years ago by the experiment stations and found to be late in maturity. The length of lint was about 1⅜ inches; the number of bolls per pound, 68.

Mattis.

Alabama Bulletin 107.

Not now grown. A local variety developed by C. F. Mattis, Learned, Miss.

Maxey.

Arkansas Third Annual Report. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 8, 16, new series. Mississippi Second and Third Annual Reports. South Carolina Bulletin 1, old series; First and Second Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Mebane. BIG-BOLL STORMPROOF GROUP.

Alabama Bulletin 140.

See Triumph.

Mercer.

Mississippi: Bolivar County.

Originator unknown. Not tested.

Meredith. BIG-BOLL GROUP.

Alabama Bulletins 130, 140. Georgia Bulletins 59, 63, 66, 75.

A local variety grown in Henry County, Ga. Originated by J. C. Meredith, Jenkinsburg, Ga. Plants not uniform, a mixture of the semicluster and long-branched types. Bolls large; percentage of lint rather low; seeds large, fuzzy, gray.

Bolls per pound, 54; seeds per pound, 3,200; average length of lint, 24.4 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 31.5.

Mexican.

Report of the Patent Office for 1849.

An old variety not now grown.

Mial.

North Carolina: Wake County.

Originator unknown. Not tested.

Miccasooky. EARLY GROUP.

Origin unknown. It is said to have been one of the parents of Shine and was probably similar to Sugar-Loaf, or King.

Mikado.

Georgia: Bibb County.

Georgia Bulletin 11. Louisiana Bulletins 26, 27, old series.

Originator unknown. An old variety tested by the Georgia Experiment Station in 1891, with the following results:

Bolls per pound, 90; per cent of lint, 31.4

Minor.

Alabama Bulletin 107. Georgia Bulletins 35, 39.

A local variety not now in cultivation. It was developed by J. D. Minor, Meriwether, Ga.

Missionary. PETERKIN GROUP.

North Carolina: Halifax and Harnett counties.

Alabama Bulletin 140. North Carolina State Board of Agriculture Bulletin for September, 1906.

Said to have been introduced by a missionary preacher. Origin unknown. The bolls are said to be larger than Peterkin, and the percentage of lint about 40. Not tested.

Mitchell, or Mitchell Twin-Boll. SEMICLUSTER GROUP.

Alabama: Franklin and Morgan counties.

Georgia: Clarke County.

Missouri: Pemiscot County.

South Carolina: Darlington and Lexington counties.

Texas: Bandera and McLennan counties.

Alabama Bulletin 140. Georgia Bulletin 39.

Developed by Henry B. Mitchell, Athens, Ga. Plants semicluster in habit of growth, with 1 to 3 limbs and with short and irregularly jointed fruiting branches; bolls medium in size; percentage of lint good; seeds rather large, fuzzy, brownish gray.

Bolls per pound, 62; seeds per pound, 3,450; average length of lint, 25.5 mm. (1 inch), varying from 23 to 29 mm.; strength of single fibers, 7.1 gms.; per cent of lint, 34.7.

Mitchell's Long-Lint. UPLAND LONG-STAPLE GROUP.

Tennessee: White County.

Said to have been originated by J. C. Mitchell, formerly of Rock Island, Tenn. Not tested.

Mitchem's Snowball. EARLY GROUP.

North Carolina: Caldwell County.

Originator unknown. It is said to have been brought to that county from South Carolina and to be an early-maturing small-boll cotton.

Money-Maker. PETERKIN GROUP.

Alabama: Coffee County.

Arkansas: Howard County.

Florida: Santa Rosa County.

Georgia: Carroll, Laurens, Madison, and Mitchell counties.

Louisiana: Ouachita Parish.

Mississippi: Benton County.

South Carolina: Anderson, Barnwell, Beaufort, and Orangeburg counties.

Georgia Bulletin 75.

A strain of Peterkin cotton introduced by the Alexander Seed Company, Augusta, Ga.

Plants of medium height; limbs 1 to 3, usually 2; fruiting branches slender; joints of medium length; leaves medium in size; bolls rather small; lint short.

Bolls per pound, 81; number of seeds per pound, 5,050; per cent of lint, 36.3.

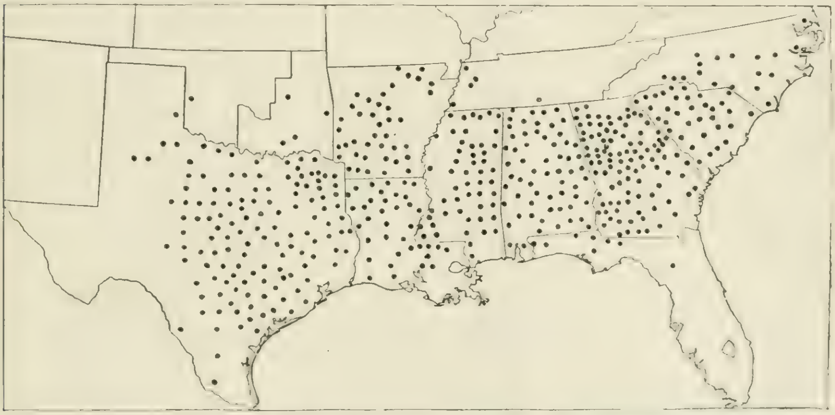

FIG. 35.—Map of the cotton-growing States, showing the distribution of Mortgage Lifter cotton in cultivation, as reported in 1907.

Montclare. BIG-BOLL GROUP.

Alabama Bulletin 140.

Not now grown. Originator unknown. A large-boll variety tested by the Department of Agriculture in 1905, and found to be a mixture of semicluster and long-branched cottons. Plants of medium height; limbs stout, 1 to 2, joints rather short and irregular or of medium length; leaves large; bolls large; percentage of lint rather low; seeds large, fuzzy, brownish gray.

Bolls per pound, 55; seeds per pound, 3,780, average length of lint, 22 mm. (⅞ inch); strength of single fibers, 4.8 gms.; per cent of lint, 31.5.

Montgomery Black-Seed.

Mississippi: Hinds and Issaquena counties.

Originator unknown. This variety is said to be the same as Black Rattler.

Moon. UPLAND LONG-STAPLE GROUP.

Arkansas: Grant, Lonoke, Pulaski, Sebastian, Sevier, and White counties.

Louisiana: Tensas Parish.

Texas: Brown, Lamar, and Red River counties.

Alabama Bulletins 107, 140. Arkansas First and Second Annual Reports. Mississippi Third Annual Report. Oklahoma Bulletin 23. Texas Bulletin 75. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Said to have been originated by Jacob Moon, Ashdown, Little River County, Ark. Plants tall and long branched, rather late in maturity; bolls medium in size; seeds fuzzy, gray; lint soft and clinging, of fair length.

Bolls per pound, 68; seeds per pound, 3,600; average length of lint, 31.4 mm. ($1\frac{7}{32}$ inches), varying from 30 to 34 mm.; strength of single fibers, 7.2 gms.; per cent of lint, 28.7.

Morman. BIG-BOLL GROUP.

Formerly grown in McCullough County, Tex. Originator unknown. Not tested.

Morning Star. BIG-BOLL STORMPROOF GROUP.

Arkansas: Miller County.

Texas: Fannin and Lamar counties.

A strain of Texas Stormproof cotton developed by J. W. Segler, of Wolf City, Tex.

Morris.

Louisiana Bulletins 8, 16, 21, 29.

Not now grown. It was developed by John O. Morris, of Gainesville, Tex.

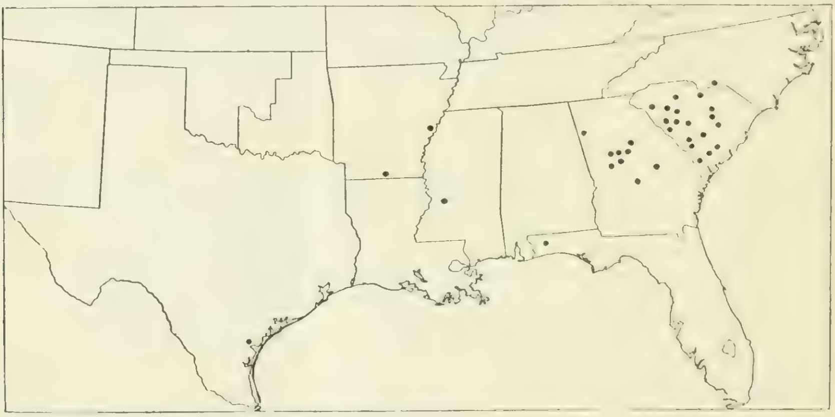

FIG. 36.—Map of the cotton-growing States, showing the distribution of Moss cotton in cultivation, as reported in 1907.

Mortgage Lifter. BIG-BOLL GROUP.

Distribution: See map, figure 35.

Alabama Bulletins 130, 140. Georgia Bulletin 75.

A trade name for Wyche, which see.

Moses Eason. PETERKIN GROUP.

Extensively grown in Walker County and also reported from Fayette County, Ala. It is stated that the bolls are of medium size, the per cent of lint 38 to 40, and the plants prolific and fairly early in maturity. Not tested.

Moss. PETERKIN GROUP.

Distribution: See map, figure 36.

Alabama Bulletin 140. Georgia Bulletins 47, 52, 56, 59, 63, 66, 70, 75. Mississippi Bulletin 98. North Carolina State Board of Agriculture Bulletin for September, 1906. South Carolina Bulletin 120.

A strain of Peterkin developed by Ben D. Moss, Norway, S. C. This variety made the very high record of 44.9 per cent of lint at the Georgia Experiment Station in 1905. Plant similar to Peterkin; bolls small; lint of medium length, percentage very high; seeds small, fuzzy, brownish gray, a few smooth and black.

Bolls per pound, 70; seeds per pound, 4,920; average length of lint, 23.3 mm. ($\frac{15}{16}$ inch), varying from 20 to 25 mm.; strength of single fibers, 6 gms.; per cent of lint, 39.1.

Multibolus.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Myers, or Meyer. BIG-BOLL STORMPROOF GROUP.

Distribution: See map, figure 37.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A strain of Bohemian cotton developed about forty years ago by a Mr. Meyer, of New Bremen, near Millheim, Austin County, Tex. Myers has become mixed with other varieties and is not as perfectly stormproof as formerly.

Plants long branched with a mixture of semicluster; limbs 1 to 2, heavy, fruiting branches drooping under the weight of bolls; leaves large; bolls large, the majority 5-locked, usually turning downward when mature, cotton remaining well in the boll; lint of medium length; seeds large, fuzzy, gray.

Bolls per pound, 64, seeds per pound, 4,100; average length of lint, 24 mm. ($\frac{15}{16}$ inch); strength of single fibers, 6.5 gms.; per cent of lint, 32.

Nancy Hanks. SEMICLUSTER GROUP.

Georgia: Putnam County.

Alabama Bulletins 107, 130, 140. Georgia Bulletins 35, 39, 43, 63, 66. South Carolina Bulletin 120. Texas Bulletin 50.

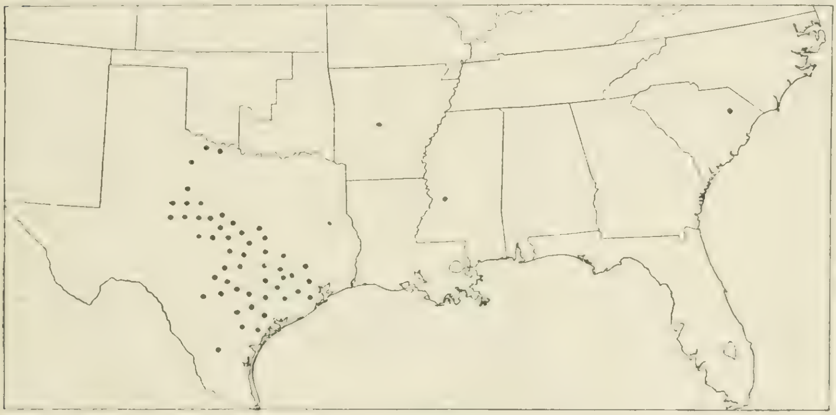

FIG. 37.—Map of the cotton-growing States, showing the distribution of Myers, or Meyer, cotton in cultivation, as reported in 1907.

A strain of Dongola developed in eastern Georgia. Originator unknown. Plant semicluster in habit, bolls medium in size, seeds of medium size, fuzzy, greenish gray.

Bolls per pound, 72; seeds per pound, 3,780; average length of lint, 24 mm. ($\frac{15}{16}$ inch); strength of single fibers, 5.7 gms.; per cent of lint, 32.

Nankeen.

Louisiana: Calcasieu Parish.

Mississippi: Carroll County.

Tennessee: Loudon County.

Alabama Bulletin 56.

An old variety almost extinct except in a few places where home weaving is still carried on. The origin of this variety is not known, but it was probably obtained by preserving the seed of the yellow-linted sports or mutations which sometimes occur in ordinary cotton. Except in color of lint, Nankeen resembles the common cotton grown in the same region.

Neely Early Prolific.

Mississippi: Clarke County.

Originator unknown. Not tested.

New Century. UPLAND LONG-STAPLE GROUP.

Arkansas: Jefferson County.

Alabama Bulletin 140. Louisiana Bulletin 62. Mississippi Bulletin 79; Fifteenth Annual Report.

This cotton was developed on the sandy uplands near Memphis, Tenn., from seed of unknown origin. It is barely a "quarter" cotton at best and when tested by the Mississippi station in 1902 the length of lint was only $1\frac{1}{8}$ inches, while the percentage was 30.

New Era.

See Oliver's New Era.

Newkirk Improved.

Texas: Delta County.

Originator unknown. Not tested.

Nicholson. BIG-BOLL STORMPROOF GROUP.

Distribution: See map, figure 38.

A strain of stormproof cotton, probably Bohemian, introduced by the Texas Seed and Floral Company, Dallas, Tex. Plant of medium size, limbs 1 to 3, fruiting branches with joints of medium length, foliage large, bolls medium to large, hanging downward when ripe, lint of medium length, seeds large, fuzzy, gray.

Bolls per pound, 69; seeds per pound, 3,475; average length of lint, 25.4 mm. (1 inch); strength of single fibers, 4.8 gms.; per cent of lint, 30.

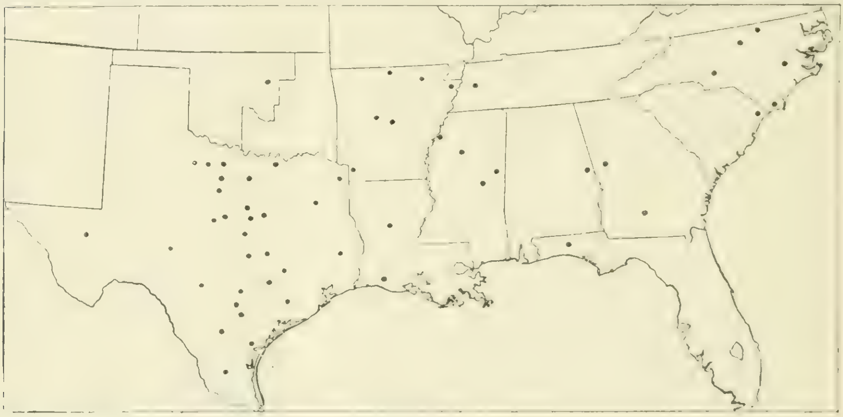

FIG. 38.—Map of the cotton-growing States, showing the distribution of Nicholson cotton in cultivation, as reported in 1907.

Ninety-Day. EARLY GROUP.

Georgia: Wake County.

A synonym of Sugar-Loaf, or King.

Nonpareil, or Woodfin's Prolific. SEMICLUSTER GROUP.

Alabama: Dallas, Hale, Marion, and Perry counties.

Georgia: Banks County.

Louisiana: East Feliciana, Ouachita, and Pointe Coupee parishes.

Texas: Houston County.

Alabama Bulletins 130, 138, 140. Alabama (Canebrake) Bulletins 22, 23. Georgia Bulletins 59, 63, 66.

Originated by Sam. V. Woodfin, Marion, Ala., by mixing Peerless, Senegambia, and Peterkin and selecting the best plants from the mixture for several years.

Plant quite similar to Peerless, limbs 1 to 3, fruiting branches short with rather short and irregular joints, bolls small, lint of good length, seeds medium in size, fuzzy, gray or brown.

Bolls per pound, 98; seeds per pound, 4,530; average length of lint, 24 mm. ($\frac{15}{16}$ inch); strength of single fibers, 4.7 gms.; per cent of lint, 31.

Norris, or Norris Big-Boll. BIG-BOLL GROUP.

Alabama Bulletins 107, 140. Georgia Bulletins 43, 47, 52, 56.

Not reported in 1907. This variety was tested several times by the Georgia and Alabama experiment stations, with the following average results:

Bolls per pound, 63; seeds per pound, 3,490; per cent of lint, 32.

Numelee's Long-Lint. UPLAND LONG-STAPLE GROUP.

Alabama: Bibb County.

Originator unknown. Not tested.

Oats, or Texas Oats. EARLY GROUP.

North Carolina: Duplin County.

Arkansas Third Annual Report.

Louisiana Bulletins 21, 22, old series; 8, 16, new series. Mississippi Third Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Bolls rather small, lint short, seeds small, smooth except a tuft of brown fuzz at small end, dark brown in color.

The following measurements were obtained from a sample grown by Thomas J. Carr, Rosehill, Duplin County, N. C.:

Bolls per pound, 87; seeds per pound, 4,670; average length of lint, 22 mm. (⅞ inch), varying from 21 to 24 mm.; strength of single fibers, 5.6 gms.; per cent of lint, 31.7.

Ochehoma Prolific.

Louisiana: De Soto Parish.

Originator unknown. Not tested.

Okra, or Okra-Leaf.

Alabama Bulletins 5, 11, 13, 16, 33, 40, 52, 56, 76, 107, 140. Alabama (Canebrake) Bulletins 7, 11, 14. Arkansas Third Annual Report. Georgia Bulletin 20. Louisiana Bulletins 27, old series; 7, 16, 17, 21, 22, 29, new series. Mississippi Bulletins 18, 23; Second, Third, Fourth, and Sixth Annual Reports. South Carolina Second Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A very distinct cotton, grown as long ago as 1837, "when it was quite common and somewhat popular." It has been preserved more as a curiosity than as a field crop, and numerous tests have been made from time to time by the experiment stations. It was generally described as an early variety with small bolls, short lint, seeds small and fuzzy, and cotton wasting badly during storms. Single plants of Okra cotton are sometimes found in fields of King and allied varieties, and several explanations have been advanced to account for their presence. A small mixture of the variety in fields of ordinary cotton would soon be swamped by cross-fertilization and would disappear, but there is a possibility that reversions would sometimes occur. It is also possible that the Okra plants may be sports or mutations which arise independently. Sir George Watt, an authority on Asiatic cottons, states that the Okra cotton formerly grown in America was an Asiatic species known as *Gossypium neglectum* Tod., or *Gossypium arboreum neglectum* Watt, and that the Okra-Leaf forms now found in King are due to hybridization of the King variety with an entirely different species called *Gossypium schottii* Watt, an obscure cotton once found growing near Merida, Yucatan. Both of these statements are open to doubt. Prof. T. H. Middleton, also well acquainted with Asiatic cottons, states that Okra cotton is apparently a hybrid between the American species *Gossypium hirsutum* L. and an Asiatic species, *G. roseum* Tod. The Okra plants occasionally found in King have been grown separately by the Department of Agriculture and the measurements given below were obtained from them. The name "Okra" was given to this variety on account of the similarity of its leaves to those of some of the narrow-lobed okras.

Plants similar to King, or Sugar-Loaf, in all respects except in shape of the leaves, which are split into 3 to 7 very narrow lobes, the middle lobe broadest, with 1 or 2 teeth or lobules at its base, the other lobes entire, flowers creamy white, petal spots often present; bolls small, 3, 4, and 5 locked, usually 4 locked, the bur opening widely and allowing the cotton to waste badly during storms; lint short; seeds small, fuzzy, brownish gray.

Bolls per pound, 108; seeds per pound, 5,670; average length of lint, 20 mm. ($\frac{25}{32}$ inch); strength of single fibers, 5.2 gms.; per cent of lint, 33.

Oliver's New Era. BIG-BOLL GROUP.

Alabama: Shelby County.

Georgia: Putnam County.

The originator of this cotton, A. A. Oliver, Calera, Ala., states that it is especially adapted to poor-land conditions and that it has been bred with that purpose in view. Bolls medium to large, seeds large, fuzzy, greenish or brownish gray.

Bolls per pound, 60; seeds per pound, 3,200; average length of lint, 25.6 mm. (1 inch), varying from 22 to 28 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 35.3.

Ott Improved. SEMICLUSTER GROUP.

South Carolina: Richland County.

A strain of Hawkins developed by W. F. Ott, Columbia, S. C. Bolls medium in size; lint rather short, percentage good; seeds small, fuzzy, brownish gray.

Bolls per pound, 78; seeds per pound, 5,560; average length of lint, 21.6 mm. ($\frac{7}{8}$ inch), varying from 20 to 23 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 37.7.

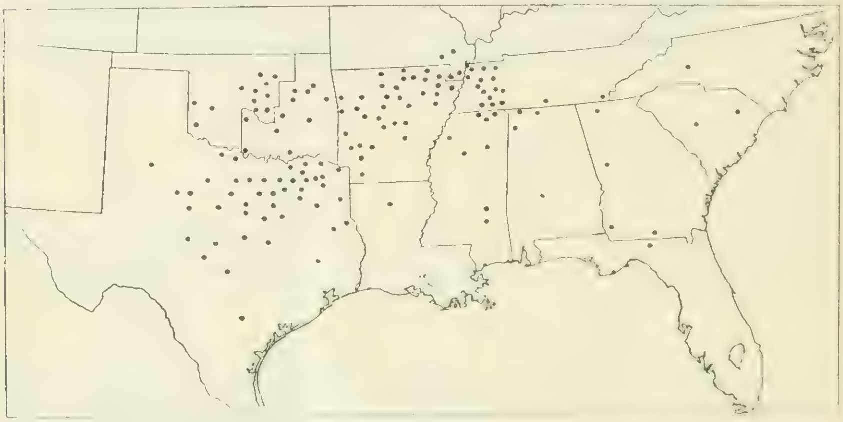

FIG. 39.—Map of the cotton-growing States, showing the distribution of Ounce-Boll cotton in cultivation, as reported in 1907.

Ounce-Boll. BIG-BOLL GROUP.

Distribution: See map, figure 39.

Oklahoma Bulletin 23.

An old variety of cotton which was probably developed in Texas or southern Arkansas. It is now badly mixed with other varieties, mostly long-staple and "quarter" cottons. When pure it is said to have been similar to Texas Stormproof, having large bolls, lint of medium length, and large white seeds. The sample from which the following measurements were taken was nearly half "staple" cotton. It was grown at Terrell, Tex., in 1904.

Bolls per pound, 84; seeds per pound, 3,475; average length of lint, 30 mm. ($1\frac{3}{16}$ inches); strength of single fibers, 4.5 gms.; per cent of lint, 31.

Owen. UPLAND LONG-STAPLE GROUP.

Texas: Red River County.

Originator unknown. It is said to have been developed near Clarksville, Tex. Not tested.

Ozier Big-Boll. BIG-BOLL GROUP.

(Also known as Ozier Green-Seed.)

Distribution: See map, figure 40.

Alabama Bulletin 140. Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports.

See Russell.

Ozier Long-Staple, or Ozier Silk. UPLAND LONG-STAPLE GROUP.

Alabama Bulletins 76, 140. Arkansas First and Second Annual Reports. Mississippi Third Annual Report. North Carolina Tenth Annual Report. South Carolina Bulletin 1, old series; First and Second Annual Reports.

See Stearns.

Parker.

Alabama: Conecuh County.

Arkansas: Cleburne County.

Georgia: Campbell and Spalding counties.

Louisiana: East Feliciana, Grant, Iberville, Pointe Coupee, Tensas, and West Feliciana parishes.

Oklahoma: Pottawattomie County.

Texas: Ellis, Gonzales, Hill, Hood, Knox, Madison, McMullen, Montgomery, Washington, Wilson, and Wharton counties.

Alabama Bulletins 130, 140. Mississippi Bulletin 87. Congressional Cotton Seed Distribution Leaflets for 1903 and 1904.

A Mississippi cotton not belonging to any particular group. It was formerly grown by John M. Parker on his plantation at Maxime, Miss., but the stock has recently become mixed with Black Rattler and other varieties and no pure Parker seed can be obtained. At Maxime, Miss., it yielded a staple of good length classed as "Benders," but when grown in a drier climate away from the Mississippi River the staple was rarely over an inch in length. Plant rather tall and slender, with 1 to 3 long limbs, and slender, fairly short jointed fruiting branches; leaves of medium size; bolls small, 3, 4, and 5 locked; lint of medium length; seeds medium in size, fuzzy, gray or greenish gray.

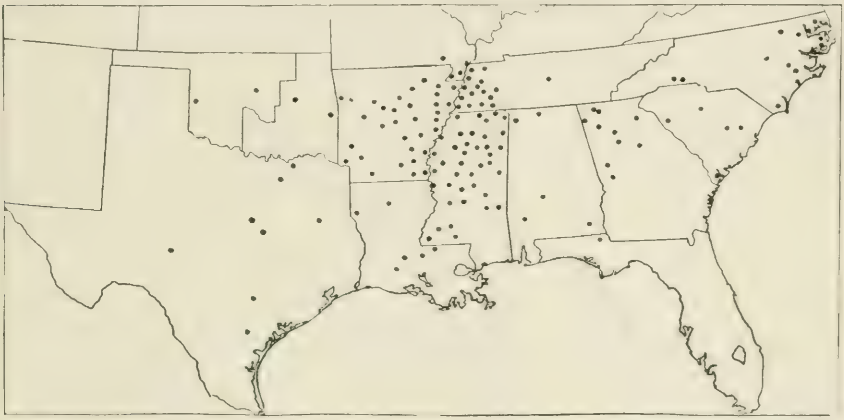

FIG. 40.—Map of the cotton-growing States, showing the distribution of Ozier Big-Boll cotton in cultivation, as reported in 1907.

The sample from which the following measurements were taken was grown by the Department of Agriculture in Waco, Tex.

Bolls per pound, 96; seeds per pound, 3,800; average length of lint, 25.5 mm. (1 inch); strength of single fibers, 5.2 gms.; per cent of lint, 30.

Parker Long-Staple. UPLAND LONG-STAPLE GROUP.

Mississippi: Lauderdale County.

Developed by Lott Parker, of Increase, Miss., from a long-staple cotton of unknown origin. Plant not seen; bolls of good size; lint fairly long, fine, and silky; seeds of medium size, fuzzy, gray and brownish gray.

Bolls per pound, 65; seeds per pound, 3,750; average length of lint, 34 mm. (1$\frac{11}{32}$ inches), varying from 30 to 36 mm.; strength of single fibers, 4.8 gms.; per cent of lint, 28.3.

Park's Own. EARLY GROUP.

Alabama: Tallapoosa County.

Mississippi: Smith County.

Louisiana: West Feliciana Parish.

Alabama Bulletins 107, 140.

A mixture of King and Russell grown by George W. Park, Alexander City, Ala. Bolls of good size, lint of medium length, seeds medium to small, fuzzy, brownish and greenish gray.

Bolls per pound, 65½; seeds per pound, 4,860; average length of lint, 25 mm. ($\frac{31}{32}$ inch), varying from 22 to 28 mm.; strength of single fibers, 6.8 gms.; per cent of lint, 35.

Patton's Round-Boll. BIG-BOLL STORMPROOF GROUP.

Developed about eight years ago by selection by a Mr. Patton, of Montague County, Tex. It has been improved and culled by Frank Mauldin, Sunset, Tex.

Bolls large, round, easily picked, but stormproof; lint of medium length, percentage good.

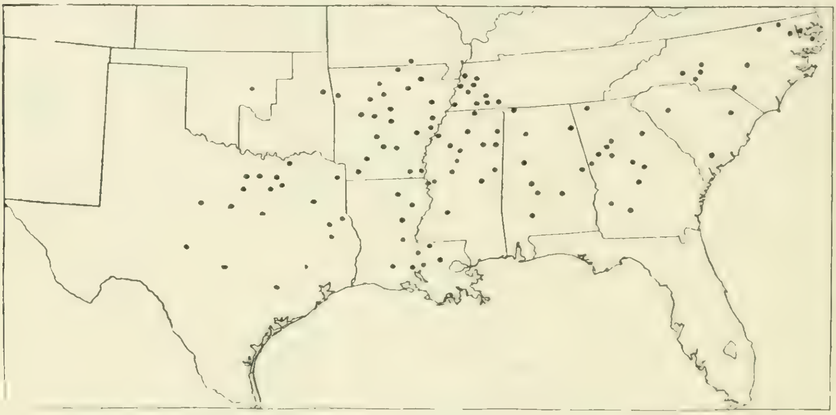

FIG. 41.—Map of the cotton-growing States, showing the distribution of Peeler cotton in cultivation, as reported in 1907.

Peabody Prolific. BIG-BOLL GROUP.

South Carolina: Sumter County.

Origin unknown. The plant is described as large and vigorous, bolls of good size, and the per cent of lint about 32. Not tested.

Peach-Bloom.

Mississippi: Issaquena County.

Originator unknown. Not tested.

Peake. PETERKIN GROUP.

See Hall.

Pearce.

North Carolina Tenth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Tested by the North Carolina station in 1887. The yield of lint is given as 32.19 per cent. The seed was obtained from T. J. King, Louisburg, N. C. Not now grown.

Peebles Choice. PETERKIN GROUP.

Louisiana: East and West Feliciana parishes.

Mississippi: Wilkinson County.

This variety was developed from a single plant of superior quality found about fifteen years ago in a field of Peterkin by L. W. Peebles, of Laurel Hill, La. It has since been selected for earliness, prolificacy, and length of staple. Mr. Peebles states that until about eight years ago this variety was known as Peebles Irene.

Plant tall growing with a strong tendency toward the semicluster habit; limbs often absent; fruiting branches of medium length below, short and irregularly jointed above; leaves of medium size; bolls small in size; seeds nearly naked or covered with a sparse short fuzz, a longer tuft at the small end.

Bolls per pound, 105; seeds per pound, 6,480; average length of lint, 23 mm. ($\frac{29}{32}$ inch); strength of single fibers, 6 gms.; per cent of lint, 33.

Peeler. UPLAND LONG-STAPLE GROUP.

Distribution: See map, figure 41.

Alabama Bulletins 33, 40, 52, 56, 107, 140. Louisiana Bulletins 22, 26, 27, old series; 8, 16, new series. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety said to have originated in Warren County, Miss., about 1864. It is not grown as extensively as formerly but is still popular in some parts of Mississippi.

Plants of medium height; limbs 2 to 3, sometimes none, coming out 5 to 6 inches above the ground, making the plants somewhat long shanked; fruiting branches slender, joints of medium length; bolls small, 3, 4, and 5 locked; lint long, fine, and silky, cotton matted in the lock, percentage low; seeds medium in size, covered by a sparse fuzz or partly naked.

The following measurements were obtained from a sample grown in Waco, Tex., by the Department of Agriculture:

Bolls per pound, 121; seeds per pound, 3,950; average length of lint, 35 mm. ($1\frac{3}{8}$ inches); strength of single fibers, 4.1 gms.; per cent of lint, 26.5.

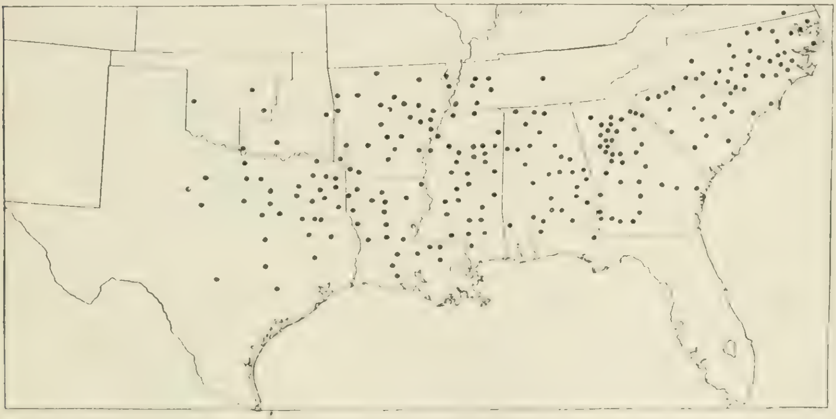

FIG. 42.—Map of the cotton-growing States, showing the distribution of Peerless cotton in cultivation, as reported in 1907.

Peelers.

A name given by cotton buyers to a class of long-staple cotton grown near the Mississippi River in Louisiana, Arkansas, and Mississippi. The variety Peeler formerly made up a considerable part of this class.

Peerless. SEMICLUSTER GROUP.

Distribution: See map, figure 42.

Alabama Bulletins 5, 12, 13, 16, 22, 33, 34, 40, 52, 56, 71, 76, 89, 101, 107, 140. Alabama (Canebrake) Bulletins 7, 11, 14, 18, 22; Twelfth and Thirteenth Annual Reports. Alabama (Wetumpka) First Annual Report. Arkansas Bulletins 18, 23; First, Second, and Third Annual Reports. Georgia Bulletins 11, 16, 20. Lousiana Bulletins 21, 22, 26, 27, old series; 7, 8, 16, 17, 21, 22, 28, 29, 35, 62, 71, new series; Third and Fourth Annual Reports. Mississippi Bulletin 18; Third and Fourth Annual Reports. North Carolina Bulletin 146; Tenth Annual Report. Oklahoma Bulletin 23. South Carolina Bulletins 1, old series; 18, 42, 120, new series. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Origin unknown. Peerless has been a popular and standard variety for many years, but pure seed is now hard to obtain and the variety has been allowed to deteriorate.

Plants 3 to 4 feet high, pyramidal in shape, limbs 1 to 3, fruiting branches short, short and irregularly jointed, about 18 inches long below, shortening to 2 or 3 inches at the top of the plant; bolls small to medium in size; lint short, percentage rather low; seeds rather small, fuzzy, greenish or brownish gray.

The following measurements were obtained from a sample grown in Waco, Tex., by the Department of Agriculture:

Bolls per pound, 69; number of seeds per pound, 4,550; average length of lint, 22 mm. ($\frac{7}{8}$ inch); strength of single fibers, 5 gms.; per cent of lint, 31.

Pelican.

Oklahoma: Lincoln County.

Texas: Falls and Franklin counties.

Described as a small to medium boll cotton rather early in maturity. Not tested. The name is perhaps a corruption of Peterkin.

Percy. UPLAND LONG-STAPLE GROUP.

Mississippi: Washington County.

Originator unknown. Not tested.

Perfection.

Georgia Bulletin 70.

Not now grown. It was tested by the Georgia station in 1905, with the following results:

Bolls per pound, 78; seeds per pound, 5,000; per cent of lint, 34.1.

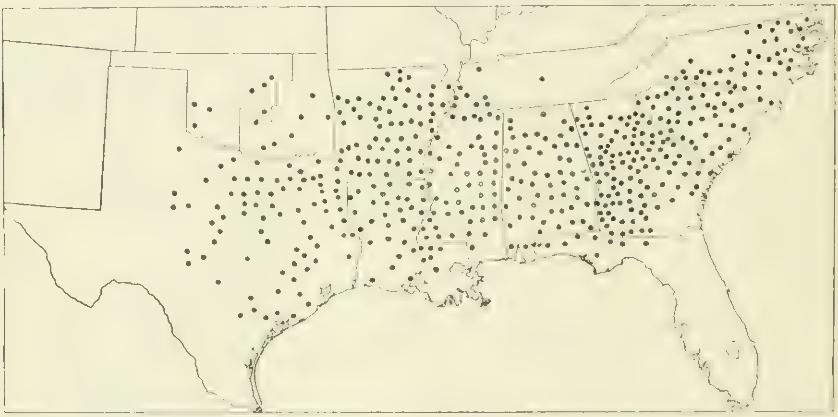

FIG. 43.—Map of the cotton-growing States, showing the distribution of Peterkin cotton in cultivation, as reported in 1907.

Perkins.

Louisiana: East Feliciana Parish.

Developed from Brannon by R. R. Perkins, Baywood, La. Plant not seen, bolls medium in size, lint of good length, seeds rather small, fuzzy, light greenish gray.

Bolls per pound, $67\frac{1}{2}$; seeds per pound, 4,360; average length of lint, 26.2 mm. ($1\frac{1}{32}$ inches), varying from 24 to 28 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 33.7.

Perry. BIG-BOLL GROUP.

Georgia: Chattooga County.

Developed by a Mr. Perry, of Gore, Ga., and said to be an early big-boll cotton. A sample obtained from W. G. Watson, Gore, Ga., tested as follows:

Bolls per pound, 59; seeds per pound, 3,740; length of lint, 24.3 mm. ($\frac{15}{16}$ inch), varying from 22 to 26 mm.; strength of single fibers, 5.8 gms.; per cent of lint, 35.6.

Peterkin. PETERKIN GROUP.

Distribution: See map, figure 43.

Alabama Bulletins 13, 16, 22, 33, 34, 40, 52, 56, 63, 76, 89, 101, 107, 130, 138, 140. Alabama (Canebrake) Bulletins 11, 14, 18, 22, 23; Twelfth and Thirteenth Annual

Reports. Alabama (Tuskegee) Bulletin 7. Arkansas Bulletins 18, 23; First, Second, and Third Annual Reports. Georgia Bulletins 11, 47, 56, 59, 66, 70, 75, 79. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 7, 8, 16, 17, 21, 22, 28, 29, 35, 47, 62, 71, new series; Third and Fourth Annual Reports. Mississippi Bulletins 18, 23, 62, 79, 83, 87, 98; Second, Third, Fourth, Eighth, Twelfth, Thirteenth, and Fifteenth Annual Reports. North Carolina Bulletin 146; State Board of Agriculture Bulletin for September, 1906; Tenth Annual Report. Oklahoma Bulletin 23 (Petican). South Carolina Bulletins 1, old series; 2, 18, 42, 120, new series. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A standard variety developed by J. A. Peterkin, Fort Motte, Orangeburg County, S. C. This variety and its many derivatives are considered preeminent for poor, droughty land and hard conditions of culture.

Mr. Peterkin states that he obtained the seed from a man named Jackson who came to South Carolina shortly after the war, bringing the seed with him. This man claimed to have obtained the seed in the "back part of Texas," and from its resemblance to the old Rio Grande cotton it is supposed to have had the same origin. Mr. Peterkin has grown the cotton for about forty years and has gradually changed it from a smooth black seed to a fuzzy seed.

Plant slender in growth, limbs 1 to 3, fruiting branches long, slender, and somewhat drooping, with almost no tendency toward the semicluster habit, joints rather long and plant later in maturity than many small-boll cottons; bolls medium to small, 70 per cent 5-locked, opening widely but cotton retained fairly well during storms; lint of medium length, wiry and strong; seeds small, covered with a short, brownish gray fuzz, a small percentage smooth and black.

Bolls per pound, 82½; seeds per pound, 5,300; average length of lint, 21.8 mm. (⅞ inch), varying from 20 to 23 mm.; average strength of fibers, 5.8 gms.; per cent of lint, 39.6.

Peterkin New Cluster. PETERKIN GROUP.

(Also known as Peterkin Limb Cluster.)

Georgia Bulletins 16, 20. Louisiana Bulletins 21, 22, 28, 29, 35. Mississippi Bulletin 23. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. Said to be similar to Peterkin except that the bolls were somewhat clustered. Developed by J. A. Peterkin, Fort Motte, S. C.

Peter's Prolific. EARLY GROUP.

A strain of King, or Sugar-Loaf. E. S. Peters, of Calvert, Tex., states that this cotton has been grown at Calvert and selected for boll-weevil conditions for several years.

Plant similar to Sugar-Loaf, bolls small, lint short, seeds rather small, fuzzy, brownish gray. The sample from which the following measurements were taken was grown at Waco, Tex., in 1907.

Bolls per pound, 108; seeds per pound, 4,440; average length of lint, 22.3 mm. (⅞ inch), varying from 19 to 27 mm.; per cent of lint, 32.

Petit Gulf.

Distribution: See map, figure 44.

Alabama Bulletins 33, 40, 52, 56, 76, 107, 140. Arkansas Third Annual Report. Louisiana Bulletins 21, 22, 26, 27, old series; 7, 8, 16, 17, 22, 28, new series; Third and Fourth Annual Reports. Mississippi Bulletins 18, 23; Third and Fourth Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Formerly grown extensively in many parts of the cotton belt, but for many years pure seed has been impossible to obtain and the variety has practically disappeared from cultivation, the cotton still grown and reported under this name being a mixture of various types. Petit Gulf was developed about 1840 by Col. H. W. Vick, of Mississippi, and by 1846 it had become very popular. Large quantities of seed were sold for planting purposes and were shipped from Petit Gulf, a small shipping point on the Mississippi River below the present city of Vicksburg.

The plant was described as large and straggling, late in maturity, with three or more limbs and long, slender fruiting branches, long jointed; leaves medium in size; bolls rather small, lint of fair length; seeds of medium size, mostly fuzzy, brownish gray.

Bolls per pound, 70 to 80; seeds per pound, 4,200; length of lint, ⅞ to 1⅛ inches; per cent of lint, 30 to 32.

Phillips. PETERKIN GROUP.

Georgia: Clarke County.

South Carolina: Bamberg, Colletin, and Orangeburg counties.

A strain of Peterkin developed by J. L. Phillips, Orangeburg, S. C. Probably not distinct from Peterkin. The percentage of lint is from 38 to 40. Not tested.

Piester's Stormproof. BIG-BOLL STORMPROOF GROUP.

(Also known as Piester's Improved and Piester's Five-Lock.)

Texas: Parker County.

Originated by J. G. Piester, Weatherford, Tex., who states that he obtained this variety by crossing selected plants of Texas Stormproof on Poor Man's Relief. The cotton obtained was selected for several years and a large-boll, stormproof cotton was fixed.

Bolls per pound, 53; seeds per pound, 3,420; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 22 to 28 mm.; strength of single fibers, 6.3 gms.; per cent of lint, 35.3.

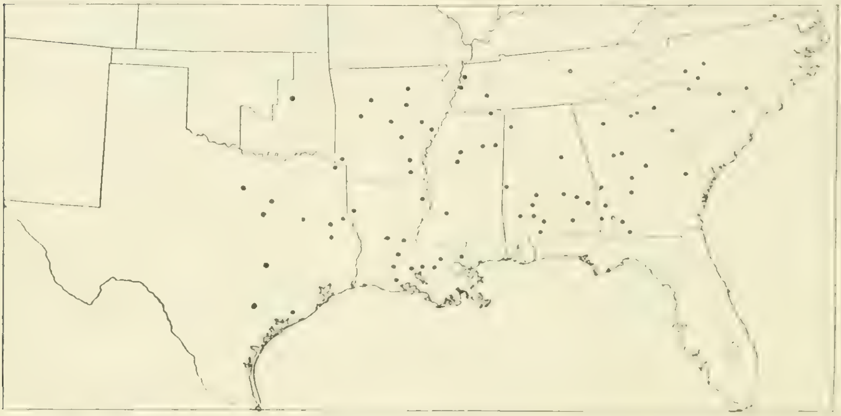

FIG. 44.—Map of the cotton-growing States, showing the distribution of Petit Gulf cotton in cultivation, as reported in 1907.

Pineapple.

Georgia Bulletin 39.

Not now grown. Tested in 1897 by the Georgia station, with the following results: Bolls per pound, 72; seeds per pound, 4,762; per cent of lint, 35.3. Seed was obtained from J. W. Farney, Monterey, Ala.

Pink-Bloom.

Mississippi: Marion County.

Tennessee: Giles County.

Originator unknown. Not tested.

Pinkerton, or Pinkerton's Select. PETERKIN GROUP.

Alabama: Covington, Lamar, and Tuscaloosa counties.

Georgia: Baker County.

Mississippi: Attala and Choctaw counties.

North Carolina: Brunswick, Gaston, and Green counties.

South Carolina: Anderson and Orangeburg counties.

Texas: San Saba and Wise counties.

Alabama Bulletins 107, 140. Georgia Bulletin 43.

A strain of Peterkin developed by H. R. Pinkerton, Eatonton, Ga. Plants similar to Peterkin; bolls medium in size; seeds rather small, fuzzy, brownish gray.

Bolls per pound, 87; seeds per pound, 4,530; average length of lint, 25 mm. ($\frac{31}{32}$ inch) strength of single fibers, 5.5 gms.; per cent of lint, 37.

Pittman's Extra-Prolific. SEMICLUSTER GROUP.

Georgia Bulletins 16, 20. Mississippi Sixth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. This variety was tested by the Georgia Experiment Station in 1892 and was described as "a tall-growing variety with short laterals and clustered, medium-sized bolls." Originator unknown.

Plains Improved. EARLY GROUP.

Texas: Crosby County.

Developed by J. R. Bolinger, of Cone, Tex. It is a cross between King and Ounce-Boll and is said to be especially suited to the plains region of western Texas. Plant not seen.

Bolls per pound, 78; seeds per pound, 4,000; average length of lint, 22.7 mm. ($\frac{29}{32}$ inch), varying from 17 to 26 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 32.1.

Podgett's Improved.

South Carolina: Colletin County.

Developed by J. C. Podgett, Williams, S. C. Not tested.

Pollock. UPLAND LONG-STAPLE GROUP.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. It was developed by W. A. Pollock, formerly of Greenville, Miss., by crossing Peerless and an unknown variety of long-staple cotton.

Pool.

Georgia: Greene County.

Originator unknown. Not tested.

Poor Man's Friend.

Arkansas: Lee County.

Louisiana: Tensas Parish.

Mississippi: Adams and Bolivar counties.

South Carolina: York County.

Tennessee: Crockett County.

Mississippi Bulletin 62; Sixth and Eighth Annual Reports.

Probably a Peterkin cotton. Tested in 1893 by the Mississippi station, where it yielded the largest amount of seed cotton of the varieties tested. In some parts of Louisiana and Mississippi the Brannon cotton is known as Poor Man's Friend.

Poor Man's Pride.

Arkansas: Lafayette County.

Originator unknown.

Poor Man's Relief. EARLY GROUP.

Missouri: Pemiscot County.

Tennessee: Obion County.

Mississippi Bulletin 18; Fourth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Originator unknown. It is described as an early, small-boll cotton yielding 33 to 35 per cent of lint, easily picked but wasting badly during storms. It is probably a strain of King.

Popcorn. UPLAND LONG-STAPLE GROUP.

Mississippi: Leflore County.

A "Bender" variety grown near Cude, Miss. Originator unknown. Not tested.

Pore's Big-Boll.

Arkansas: Independence County.

Originator unknown. Not tested.

Pride of Georgia. BIG-BOLL GROUP.

Distribution: See map, figure 45.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 39, 75, 79. Congressional Cotton Seed Distribution Leaflets for 1904 and 1906.

Developed from Jones Improved by J. F. Jones, of Hogansville, Ga. It is therefore a strain of Wyche and retains many of the good qualities of this standard variety, and in addition is somewhat earlier in maturity, the joints of the fruiting branches being shorter and inclined to semicluster slightly, while the bolls are somewhat smaller. The following measurements were taken from a sample grown at the Georgia Experiment Station in 1907:

Bolls per pound, 68½; seeds per pound, 3,700; average length of lint, 24.2 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; strength of single fibers, 6.1 gms.; per cent of lint, 33.1.

Pride of Louisiana. UPLAND LONG-STAPLE GROUP.

Louisiana: Caddo Parish.

A strain of Allen developed by D. F. Barr, Vivian, La. Not tested.

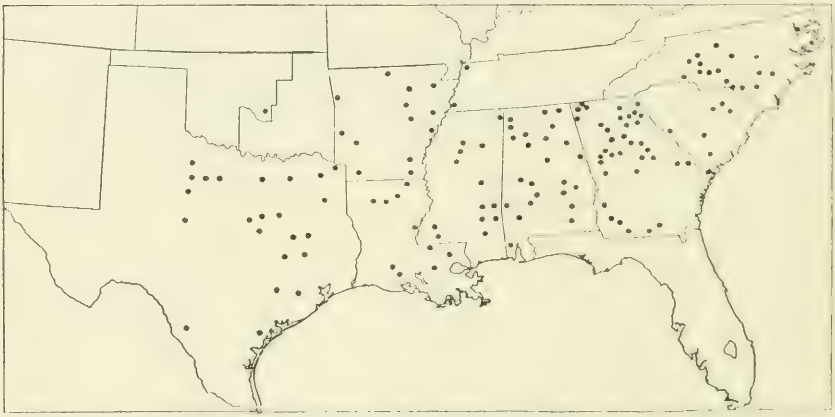

FIG. 45.—Map of the cotton-growing States, showing the distribution of Pride of Georgia cotton in cultivation, as reported in 1907.

Pride of the Valley. BIG-BOLL STORMPROOF GROUP.

Texas: Fannin County.

A strain of Woodall selected by Henry Morrison, Savoy, Tex.

Prize.

See Lewis Prize.

Ptomey Champion. SEMICLUSTER GROUP.

Alabama: Cleburne County.

Alabama Bulletin 140.

Originated by J. W. Ptomey, Forest Home, Ala. Plant semicluster in habit of growth; bolls small; seeds fuzzy, gray and brownish gray.

Bolls per pound, 91; seeds per pound, 4,550; average length of lint, 24 mm. ($\frac{15}{16}$ inch); strength of single fibers, 4.5 gms.; per cent of lint, 32.

Pulnott, or Pullnott. BIG-BOLL GROUP.

Distribution: See map, figure 46.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 56, 63, 66, 70, 75, 79.

Originated by William Pulnott, formerly of High Shoals, Oconee County, Ga. Pulnott has been a popular variety in northeastern Georgia for many years, but it is now being superseded to some extent by Cook's Improved and especially by Long-Shank. It is well suited to poor, worn-out lands, but does not become "weedy" when grown on rich soil, and is as nearly a general-purpose cotton as Peterkin.

Plant stocky and compact in growth, with 1 to 3 limbs; fruiting branches rather short and irregularly jointed, the lower branches 18 inches long, the upper shortening to 2 or 3 inches; leaves of medium size, bolls large; 66 per cent 5-locked; lint of medium length; seeds medium in size, fuzzy, brownish or greenish gray.

The following measurements were obtained from a sample of this variety grown at the Georgia Experiment Station in 1907:

Bolls per pound, 58; seeds per pound, 3,810; average length of lint, 22.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 25 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 35.1.

Purple-Bloom. EARLY GROUP.

Arkansas: Pope County.

This variety is said to be an early, small-boll cotton, with a good percentage of lint. It is perhaps a local name for King. Not tested.

Queen of Africa. BIG-BOLL STORMPROOF GROUP.

See Rowden.

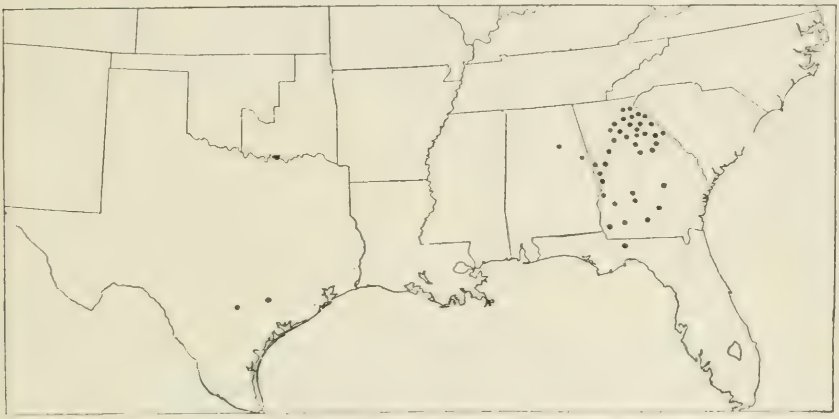

FIG. 46.—Map of the cotton-growing States, showing the distribution of Pulnott, or Pullnott, cotton in cultivation, as reported in 1907.

Rameses, or Baker's Rameses. EARLY GROUP.

Alabama Bulletins 5, 12, 13, 16, 33, 56, 107, 140; Report for 1881–82. Alabama (Canebrake) Bulletins 7, 11, 14. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown. Tested about twenty years ago by several stations and described as a prolific, long-branched cotton; bolls round in shape, 83 per pound; per cent of lint, 27 to 29; lint short, from ½ to ⅞ inch in length. Originator unknown.

Ramsey. EARLY GROUP.

Arkansas: Grant County.

Texas: Van Zandt County.

A cross between King and Texas Stormproof developed by W. T. Ramsey, Canton, Tex. Bolls of good size; lint rather short; seeds fuzzy, light brownish or greenish gray.

Bolls per pound, 62; seeds per pound, 3,600; average length of lint, 22.4 mm. (inch), varying from 20 to 24 mm.; strength of single fibers, 7.2 gms.; per cent of lint, 33.9.

Ransom's Early. EARLY GROUP.

Mississippi: Grenada County.

Originated by E. M. Ransom, Grenada, Miss., by selection for earliness. Plant not seen; bolls rather small; lint of fair length; seeds small, fuzzy, greenish or brownish gray.

Bolls per pound, 82½; seeds per pound, 4,700; average length of lint, 24.5 mm. (inch), varying from 22 to 27 mm.; strength of single fibers, 5.8 gms.; per cent of lint, 32.8.

Ratterree's Favorite.

Arkansas: Lincoln County.

A very distinct variety found in 1898 by W. J. Ratterree in his field cotton at Garnett, Ark. It is similar to the intermediate plants obtained when Okra cotton is crossed with an ordinary Upland variety. Mr. Ratterree supposes it to be a form of Texas Oak or Peterkin, which he was growing at the time, but Okra cotton has not, hitherto, been found in Peterkin.

Plants of medium height, with 1 to 3 limbs and fairly short jointed fruiting branches; leaves cleft to within one-half inch of the base into 3 to 5 very smooth lanceolate lobes; petioles and branches nearly glabrous; young shoots hairy; flowers creamy white, without petal spots; bolls medium in size; seeds small, nearly smooth, and black except a tuft of brownish gray fuzz at one end.

Bolls per pound, 68; seeds per pound, 4,940; average length of lint, 23.8 mm ($\frac{15}{16}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 32.5.

Rattlesnake.

Formerly grown in Tensas Parish, La. Originator unknown.

Reaves's Select. EARLY GROUP.

South Carolina: Marion County.

A strain of King, or Sugar-Loaf, developed by C. M. Reaves, Mullins, S. C., and said to yield nearly 40 per cent of lint. Not tested.

Red African.

Texas: San Saba County.

Originator unknown. Not tested.

Red Rustproof.

South Carolina: Lee County.

Originator unknown. Not tested. A red rustproof cotton was also reported from Texas.

Red-Shank. BIG-BOLL GROUP.

A large-boll variety formerly grown in Kaufman County, Tex. The plant in habit of growth was typical of the big-boll group, but the limbs and branches, petioles, and peduncles were dark red, the leaves green, involucre reddish green, and the immature bolls red except where shaded by the flowers; involucre creamy white. Red-Shank differed from Willet Red-Leaf in being a big-boll cotton and in having green leaves and clear creamy white flowers.

Lint of good length; seeds large, fuzzy, gray.

Bolls per pound, 62; seeds per pound, 2,835; average length of lint, 25.5 mm. (1 inch); strength of single fibers, 6.4 gms.; per cent of lint, 31.

Reed Prolific. BIG-BOLL GROUP.

Arkansas: Marion County.

Originated by E. T. and S. J. Reed, further selections having been made by the latter at Comal, Ark. It is described as a large-boll cotton, 60 bolls per pound, with lint over an inch long. Not tested.

Reeve. UPLAND LONG-STAPLE GROUP.

Mississippi: Bolivar County.

Developed by George P. Reeve, Vicksburg, Miss. It is described as a medium to large boll, 5-locked cotton, producing a fine, silky lint from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length. Not tested.

Reliable. BIG-BOLL GROUP.

Alabama Bulletin 140. Georgia Bulletins 66, 70, 75.

Not reported in 1907. This variety was tested by the Georgia station in 1903–4, with the following average results:

Bolls per pound, $57\frac{1}{2}$; seeds per pound, 3,125; per cent of lint, 34. Seed was obtained from E. S. Rakestraw, La Grange, Ga.

Rich Man's Pride. PETERKIN GROUP.

Georgia: Clarke and Troup counties.

Louisiana: Bossier Parish.

Alabama Bulletin 140. Georgia Bulletin 66.

A variety related to Bate's Little Brown-Seed developed by E. W. Bond, formerly of Winterville, Ga.

Plant forming a low, compact bush, early in maturity, limbs 1 to 3, fruiting branches short jointed but not semiclustered; leaves small, thick, dark green, and somewhat glossy; bolls very small, 3, 4, and 5 locked; lint of medium length; percentage very high; seeds small, covered with a short, light-brown fuzz; cotton wasting badly during storms. Ginners state that this cotton is very hard to gin, the seeds being very small and the lint strongly attached.

Bolls per pound, 120; seeds per pound, 6,000; average length of lint, 22 mm. ($\frac{7}{8}$ inch); strength of single fibers, 5 gms.; per cent of lint, 36 to 42.

Richardson, or Richardson's Improved.

South Carolina Bulletin 1, old series; First and Second Annual Reports.

An old variety reported only from Hyde County, N. C. Originator unknown. Not tested.

Rio Grande.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Probably not now in cultivation. It was a small-boll variety, yielding a high percentage of lint, and was closely related to the Peterkin cottons of to-day.

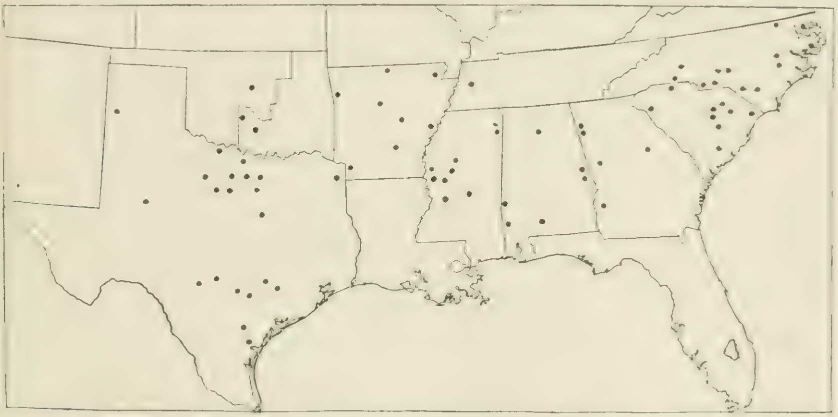

FIG. 47.—Map of the cotton-growing States, showing the distribution of Rogers, or Rogers Big-Boll, cotton in cultivation, as reported in 1907.

Roach Big-Boll.

A local variety grown in Collin County, Tex. Not tested.

Roberts, or Strahan. BIG-BOLL STORMPROOF GROUP.

Texas: Bosque, Coryell, Falls, Haskell, Knox, McLennan, and Tarrant counties.

Tennessee: White County.

Developed by selection from Myers and Bohemian by Messrs. Roberts and Strayhan, of Rosenthal, McLennan County, Tex.

A stormproof cotton quite similar to Rowden, but later in maturity. Plants large and vigorous, fruiting branches rather long jointed, leaves large; bolls large, the majority 5-locked; lint of medium length, strong; seeds large, fuzzy, light brownish gray or nearly white.

Bolls per pound, 52; seeds per pound, 3,000; average length of lint, 25 mm. (1 inch); strength of single fibers, 6.9 gms.; per cent of lint, 33.

Robinson. BIG-BOLL STORMPROOF GROUP.

Texas: Milan County.

Developed by T. P. Robinson, Bartlett, Tex., by selection from stormproof cottons. Bolls large, about 50 per pound; seeds very large; per cent of lint, about 33.3. Not tested.

Rockett Favorite.

Louisiana Bulletins 16, 21, 29.

Not now grown. Tested by the Louisiana station about fifteen years ago, the average per cent of lint, 32.6 and 34.3, only being reported. Seed from J. C. Rockett, Farmersville, La.

Roe Early.

Louisiana Bulletins 22, 28. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not reported in 1907. Tested by the Louisiana station in 1893. The percentage only is reported, 29.

Rogers, or Rogers Big-Boll. BIG-BOLL GROUP.

Distribution: See map, figure 47.

Alabama Bulletins 138, 140. South Carolina Bulletin 2; First and Second Annual Reports. Congressional Cotton Seed Distribution Leaflet for 1906.

Originated by R. H. Rogers, Darlington, S. C., from a mixture of Jones, Jowers, and Herlong.

Plant strong growing and stocky, medium to late in maturity, with 1 to 3 heavy limbs, and fruiting branches fairly short jointed with a slight tendency toward the semicluster habit; bolls round or with a blunt apex, the majority 5-locked, medium to large in size; fairly stormproof; lint of medium length and percentage; seeds large, fuzzy, gray.

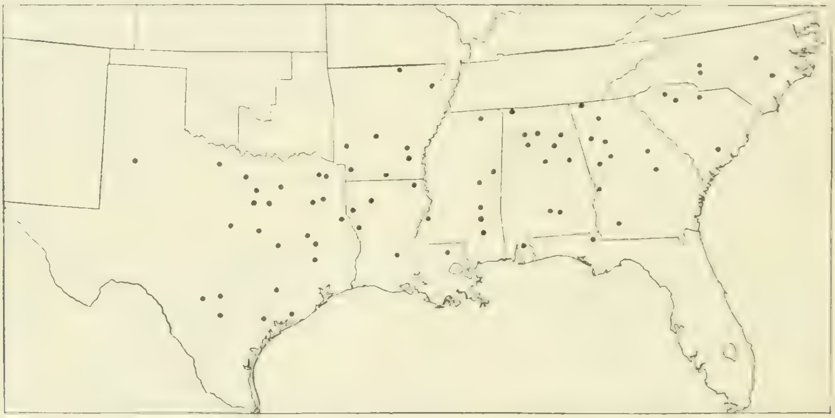

FIG. 48.—Map of the cotton-growing States, showing the distribution of Rosser No. 1 cotton in cultivation, as reported in 1907.

Bolls per pound, 52; seeds per pound, 3,150; average length of lint, 23.6 mm. ($\frac{15}{16}$ inch), varying from 22 mm. to 25 mm.; strength of single fibers, 5.5 gms.; per cent of lint, 32.

Rosser No. 1.

Distribution: See map, figure 48.

Alabama Bulletin 140. Georgia Bulletin 70.

When first tested this commercial variety proved to be an almost "raw" mixture of King and some big-boll cotton, but the two types have become somewhat assimilated, so that it is now a small to medium boll cotton intermediate between the early and big-boll groups. The following measurements were obtained from a sample grown at Waco, Tex.:

Bolls per pound, 87; seeds per pound, 4,100; average length of lint, 22.4 mm. to 26 mm. ($\frac{7}{8}$ to $1\frac{1}{32}$ inches); strength of single fibers, 5.5 gms.; per cent of lint, 31.

Round-Boll.

(Also known as the Wilkinson or Walston Round-Boll.)

North Carolina: Edgecomb, Greene, and Wayne counties.

Originator unknown. It is described as a medium-sized, round-boll cotton, yielding from 35 to 40 per cent of lint.

Rowden. BIG-BOLL STORMPROOF GROUP.

(Also known as African Queen.)

Distribution: See map, figure 49.

Alabama Bulletins 138, 140.

A standard variety which has become, perhaps, the most popular cotton grown in Texas. It was developed from Bohemian cotton by the Rowden Brothers, Wills Point, Van Zandt County, Tex. The seed was first obtained by H. H. Carmack, of Wills Point, in the fall of 1897 when traveling through the bottoms of the Sulphur Fork about 50 miles north of Van Zandt County. Mr. Carmack states that he found an excellent variety in cultivation on the bottom land and obtained a couple of bolls of the grower, who told him it was the Bohemian cotton. These bolls were given to Mr. Rowden, who was then a renter on the Carmack farm, and the Rowden cotton was developed from them. By a mistake Mr. Rowden supposed the seed to be of Florida origin.

Rowden cotton is medium early in maturity and is well adapted to the weevil conditions of Texas. Plants vigorous, but stocky in growth; limbs stout, 1 to 3; fruiting branches from 2 feet at the base to 6 inches at the top in length; joints regular and of medium length, the branches and usually the whole plant drooping beneath the weight of maturing bolls, which hang downward when ripe, the locks of cotton clinging together in a single mass, which hangs down beneath the open boll, protected by the broad segments of the bur and the large involucre, the locks clinging to the bur more than is the case with varieties lacking stormproof qualities; cotton easily picked; bolls large, the majority 5-locked; lint of medium length; seeds large, fuzzy, grayish white.

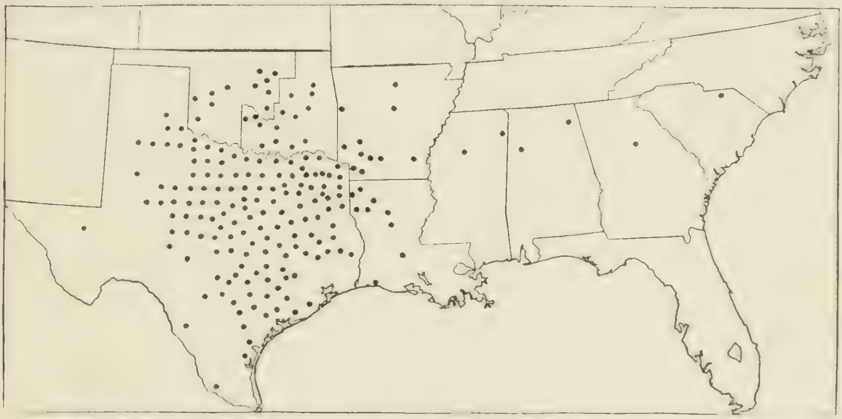

FIG. 49.—Map of the cotton-growing States, showing the distribution of Rowden cotton in cultivation, as reported in 1907.

Bolls per pound, $49\frac{1}{2}$; seeds per pound, 3,360; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 23 to 25 mm.; strength of single fibers, 6.3 gms.; per cent of lint, 35.4.

Rublee. SEMICLUSTER GROUP.

(Also known as "Rublee's Leafless Anti-Boll-Weevil Cotton.")

Texas: Collin, Dallas, Titus, and Wood counties.

Developed by C. A. Rublee, Seago, Tex. This variety is claimed to be early maturing and defoliate and to be especially suited to boll-weevil conditions.

Plant semicluster in habit of growth, resembling Hardin, imperfectly defoliate, many plants retaining their leaves and putting on squares late in the fall, bolls medium to small in size, lint short, seeds medium in size, fuzzy, light greenish or brownish gray.

The following measurements were made from a sample of seed cotton obtained from Mr. Rublee's farm in 1907. The bolls are probably smaller than usual on account of the very dry season.

Bolls per pound, 96½; seeds per pound, 3,600; average length of lint, 22.3 mm. (⅞ inch), varying from 18 to 25 mm.; strength of single fibers, 6.3 gms.; per cent of lint, 33.

Ruralist. BIG-BOLL GROUP.

Distribution: See map, figure 50.

Alabama Bulletin 140.

A variety introduced by J. F. Merriam, editor of the Southern Ruralist. It is the old Texas Bur variety renamed and said to have been culled of its impurities.

See Texas Bur for description.

Russell. BIG-BOLL GROUP.

(Also known as Big-Boll Green-Seed, Ozier Big-Boll, and Green and Gray.)

Distribution: See map, figure 51.

Alabama Bulletins 101, 107, 130, 138, 140. Alabama (Canebrake) Bulletins 22, 23. Alabama (Tuskegee) Bulletin 7. Alabama (Wetumpka) First Annual Report. Georgia Bulletins 43, 47, 52, 56, 59, 63, 66, 79. Louisiana Bulletins 62, 71. Mississippi Bulletins 79, 84, 87, 88, 98; Fifteenth and Seventeenth Annual Reports. North Carolina State Board of Agriculture Bulletin for September, 1906. South Carolina Bulletin 120. Congressional Cotton Seed Distribution Leaflets for 1902 and 1904.

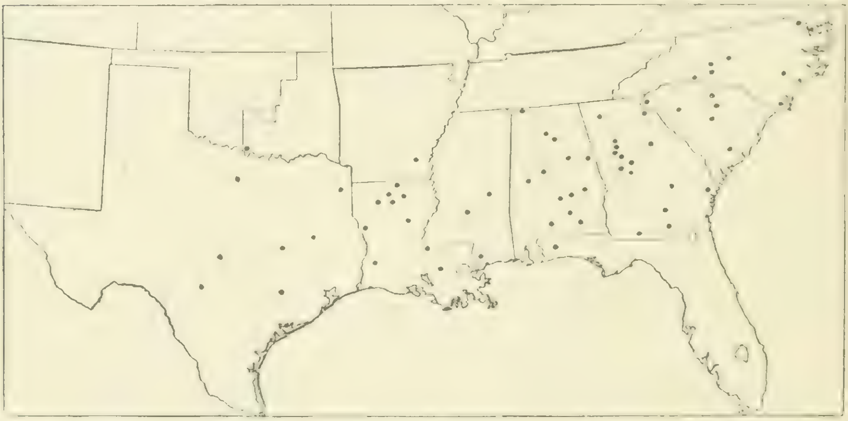

FIG. 50.—Map of the cotton-growing States, showing the distribution of Ruralist cotton in cultivation, as reported in 1907.

A standard variety originated in 1895 from a single stalk of cotton found by the late J. T. Russell, of Alexander City, Ala., in his field of cotton. Mr. Russell was growing an impure strain of Truitt at the time and supposed this plant to have been a cross between Truitt and Allen Long-Staple. It bears no resemblance to the latter variety, however, and it seems more probable that it was a sport or mutation from Truitt. Duggar[a] suggests that Russell may be identical with Bancroft's Herlong, but while the color of the seed is quite similar to the latter the general habit of the plant is less semiclustered and resembles Truitt more closely. The bolls are distinct in shape from either Truitt or Herlong. Since Mr. Russell's death the seed of this variety has been in charge of S. J. Thornton, of Alexander City.

Plant large growing, vigorous, with 1 to 3 stout limbs; fruiting branches 2 feet long below, 6 to 8 inches long at the top of the stalk; joints of medium length, leaves large, bolls large, 4 to 5 locked, fairly stormproof, the shell very thick, making the bolls somewhat less liable to injury by insects; lint of good length, percentage rather low; seeds large, covered by a dark green fuzz. The color of the fuzz is objectionable, making a poor grade of linters and sometimes, if the seed is ginned too close, injuring the lint sample by discoloring it.

The following measurements were made from a sample of this variety grown at Auburn, Ala., in 1907:

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[a] Duggar, J. F. Bulletin 140, Alabama Agricultural Experiment Station, p. 64.

Bolls per pound, 56½; seeds per pound, 3,100; average length of lint, 24.9 mm. ($\frac{31}{32}$ inch), varying from 23 to 27 mm.; strength of single fibers, 5.5 gms.; per cent of lint, 30.9.

Sandy Land Staple. UPLAND LONG-STAPLE GROUP.

Arkansas: Miller County.

Texas: Cass County.

A long-staple cotton which is said to be especially suited to rather poor, sandy uplands. It is probably the same as Boozer.

Schley. BIG-BOLL GROUP.

Distribution: See map, figure 52.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 47, 52, 56, 59, 63, 66, 70, 75, 79. Mississippi Bulletins 88, 98.

A strain of Jones Improved selected by the Georgia Experiment Station and named in honor of Admiral Schley. Mr. Kimbrough, manager of the experiment farm, states that in the tests conducted at the station Jones Improved showed evident signs of deterioration and this selection was made in order to preserve the good qualities of the variety.

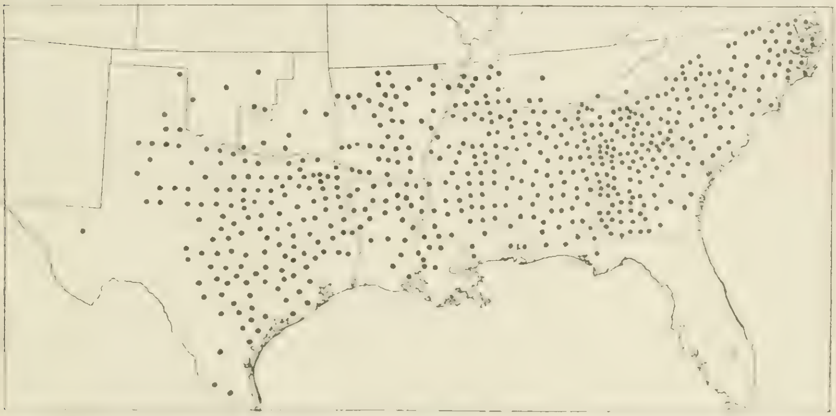

FIG. 51.—Map of the cotton-growing States, showing the distribution of Russell cotton in cultivation, as reported in 1907.

Plant similar to Jones Improved, bolls medium to large, lint short, percentage good, seeds large, fuzzy, gray.

Bolls per pound, 63; seeds per pound, 3,640; average length of lint, 23 mm. ($\frac{29}{32}$ inch), varying from 21 to 26 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 36.4.

Schooley.

Formerly grown extensively in Lancaster County, S. C. Not reported in 1907. Originator unknown.

Scogin Prolific. BIG-BOLL GROUP.

Alabama Bulletin 140. Georgia Bulletin 59.

Not reported in 1907, and probably not in cultivation. Tested by the Georgia station in 1907, with the following results:

Bolls per pound, 68; seeds per pound, 3,500; per cent of lint, 33.3. It was developed by J. T. Scogin, Grantville, Coweta County, Ga., from a mixture of Wyche and Culpepper.

Scroggins Prolific. BIG-BOLL GROUP.

Alabama Bulletin 107.

Not now grown. Developed by J. T. Scroggins, Luthersville, Ga., and tested by the Alabama Agricultural Experiment Station in 1899, with the following results:

Bolls per pound, 64; seeds per pound, 3,200; per cent of lint, 31.9.

Sego. UPLAND LONG-STAPLE GROUP.

Louisiana: Madison Parish.

A local strain of Eureka (Keno) developed by selection by a Mr. Sego, of Duckport, La.

The plant is similar to Keno, but earlier in maturity; bolls medium in size; lint fine and silky, $1\frac{5}{16}$ inches in length, per cent, 27.7.

Senegambia. BIG-BOLL GROUP.

Alabama: Hale County.

A large-boll, late variety, yielding 33 per cent of lint, medium in length. This variety is said to be one of the parents of Woodfin's Nonpareil. Originator unknown.

Sentells Cluster.

Georgia: Chattooga County.

Originator unknown. Not tested.

Shanghai. SEMICLUSTER GROUP.

Georgia: Putnam County.

A corruption of Shank-High. *See* Long-Shank.

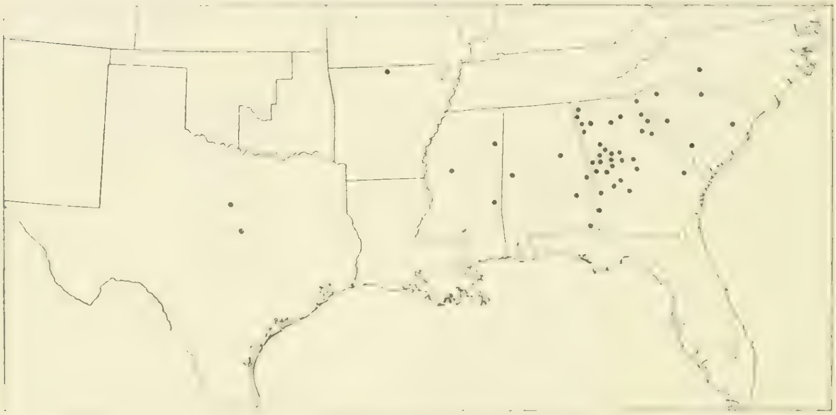

FIG. 52.—Map of the cotton-growing States, showing the distribution of Schley cotton in cultivation, as reported in 1907.

Shank-High. SEMICLUSTER GROUP.

Georgia Bulletin 79.

See Long-Shank.

Shaw. UPLAND LONG-STAPLE GROUP.

Texas: Fannin County.

Originator unknown. A medium long-staple variety brought to Fannin County from Red River County, Tex. Not tested.

Sheepnose. BIG-BOLL GROUP.

Arkansas: Conway and Logan counties.

Oklahoma: Ponteloc and Pottawatomie counties.

Originator unknown. A popular variety where grown. It is described as an early, large-boll cotton, mostly 5-locked, the bolls very round and with no sharp points on the burs. It is probably the same as Jackson Round-Boll. Not tested.

Shield's Early. BIG-BOLL GROUP.

Alabama: Dekalb and Marshall counties.

Developed by David Shields, Albertville, Ala. This variety is described as early in maturity, with large, 5-locked bolls, which open well, making the cotton easy to pick; seeds large, fuzzy, light brownish or greenish gray.

Bolls per pound, 59; seeds per pound, 3,660; average length of lint, 24.4 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; strength of single fibers, 5.4 gms.; per cent of lint, 35.3.

Shine. EARLY GROUP.

(Also known as Shine's Extra-Early Prolific, Shine's Improved, etc.)

Distribution: See map, figure 53.

Alabama Bulletins 76, 107, 130, 138, 140. Arkansas Bulletin 18; First and Third Annual Reports. Georgia Bulletins 52, 63. Louisiana Bulletins 13, 21, 22, 26, 27, old series; 8, 16, new series. Mississippi Bulletins 18, 62, 83; Third, Fourth, and Thirteenth Annual Reports. North Carolina Bulletin 146; State Board of Agriculture Bulletin for September, 1906. South Carolina Bulletins 1, old series; 120, new series; First and Second Annual Reports. Congressional Cotton Seed Distribution Leaflet for 1904. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Originated by J. A. Shine, Faison, N. C., from a mixture of Miccasooky and Sea Island. No trace of Sea Island parentage can be detected in the variety now, and it is probably very like the former parent. Shine can be distinguished from King, which it closely resembles, by the absence of petal spots.

Plant slender in growth and quite pubescent, limbs 1 to 3, fruiting branches close together and short jointed, but not semiclustered; bolls small, cotton wasting badly during storms; lint short; seeds small, fuzzy, brownish gray. This variety has been highly recommended for boll-weevil regions, but the bolls are too small and are lacking in stormproof qualities.

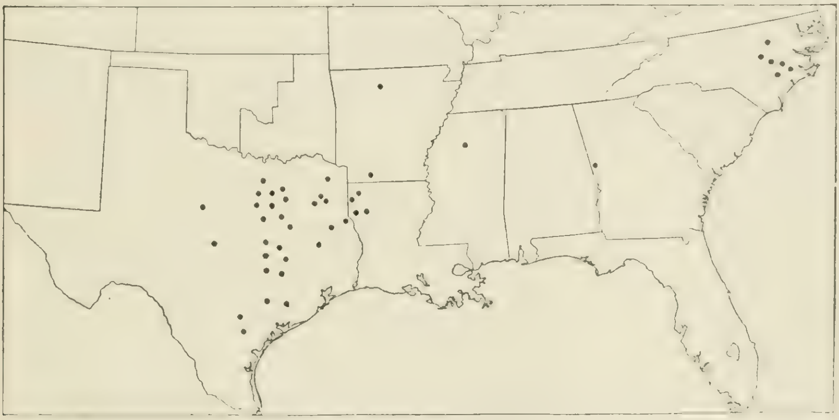

FIG. 53.—Map of the cotton-growing States, showing the distribution of Shine cotton in cultivation, as reported in 1907.

The following measurements were obtained from a sample grown at the Alabama station in 1907:

Bolls per pound, 82½; seeds per pound, 4,940; average length of lint, 22.2 mm. ($\frac{7}{8}$ inch), varying from 18 to 25 mm.; strength of single fibers, 6 gms.; per cent of lint, 36.4.

Shoe-Heel. EARLY GROUP.

A variety formerly grown locally in South Carolina. Originator unknown. Probably the same as Texas Shoe-Heel.

Sigler, or Segler. BIG-BOLL GROUP.

See Morning Star.

Silas. BIG-BOLL GROUP.

Georgia: Wilkinson County.

Originator unknown. It is described as a large-boll cotton yielding a short staple, the per cent of lint about 33.3, early in maturity.

Simms. UPLAND LONG-STAPLE GROUP.

Arkansas: Stone County.

Georgia: Coweta County.

Louisiana: Acadia Parish.

South Carolina: Aiken, Bamberg, Barnwell, Florence, Hampton, and Orangeburg counties.

Alabama Bulletins 130, 140. Georgia Bulletins 56, 59. South Carolina Bulletin 120.

A Mississippi "staple" cotton which was taken to South Carolina by a cotton buyer. Some of the seed was purchased by Mrs. W. G. Simms, of Barnwell, S. C., and the seed was sold for some time as Simms Long-Staple. It was renamed by L. A. Stoney, of Allendale, Barnwell County, who called it Floradora and advertised the seed widely under this name throughout the South.

Plant quite similar to Allen, rather slender and pyramidal in shape, tall, limbs 1 to 3, upright in growth, fruiting branches slightly ascending, 2 feet long below, somewhat semiclustered; bolls small, pointed; lint of good length, fine and silky; seeds fuzzy, light brownish gray.

Bolls per pound, 73; seeds per pound, 3,900; average length of lint, 31.7 mm. ($1\frac{1}{4}$ inches), varying from 25 to 36 mm.; per cent of lint, 28.9.

Simpkins's Prolific. EARLY GROUP.

North Carolina: Anson, Beaufort, Gaston, Johnson, Jones, Mecklenburg, Montgomery, and Wake counties.

An early variety developed by a selection from King made in 1900 by W. A. Simpkins, Raleigh, N. C. In our test the bolls proved to be somewhat larger than King, while the percentage of lint, which is claimed to be much higher as a rule than King, was about the same.

Simpson.

Alabama: Tallapoosa County.

Georgia: Campbell and Putnam counties.

South Carolina First and Second Annual Reports.

Said to have been originated by James Simpson, Stonewall, Ga. Not tested.

Simpson's Early.

Georgia Bulletin 16. South Carolina Bulletin 1, old series.

Not now grown.

Sinclair. EARLY GROUP.

Originated by Noah Sinclair, formerly of Mackey, Cherokee County, Ala.

Plant early in maturity, bolls medium in size, per cent of lint, 35. The seed has become impure.

Smith [Robert]. PETERKIN GROUP.

Said to have been developed by Robert Smith, formerly of Jones County, Ga. Bolls medium in size; seed very small; per cent of lint, 37. Not tested.

Smith Improved Unknown, or Smith Improved. BIG-BOLL GROUP.

Georgia: Jones and Wilcox counties.

Alabama Bulletins 101, 107, 140. Georgia Bulletins 39, 43, 59, 66. Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports. Texas Bulletin 50.

Developed by F. J. Smith, Vinson, Ga., and tested by the Georgia station. The average results were:

Bolls per pound, 67; seeds per pound, 3,775; per cent of lint, 34.7. Not reported in 1907.

Smith's Poor-Land. PETERKIN GROUP.

Georgia: Madison County.

See Bates Poor-Land.

Smith's Standard. Big-Boll Group.

(Also known as Ben Smith and Smith's Choice.)

Alabama Bulletins 76, 140. Georgia Bulletins 16, 20, 56. Louisiana Bulletins 27, old series; 8, 16, 22, 28, new series. Mississippi Bulletins 18, 23, 62; Third, Fourth, Sixth, and Eighth Annual Reports. Bulletin 33, Office of Experiment Stations. U. S. Dept. of Agriculture.

Not now grown. It was developed by Ben Smith, Vernon, La.

Southern Hope. Upland Long-Staple Group.

Distribution: See map, figure 54.

Alabama Bulletins 13, 16, 22, 33, 34, 40, 56, 76, 107, 140. Alabama (Canebrake) Bulletin 18; Twelfth Annual Report. Arkansas Bulletin 18; Second Annual Report. Georgia Bulletins 11, 20, 24. Louisiana Bulletins 21, 26, old series; 7, 16, 17, 21, 22, 28, 29, 35, new series. Mississippi Bulletins 18, 23, 62, 98; Third and Fourth Annual Reports. South Carolina Bulletins 2, 18; First and Second Annual Reports. Texas Bulletins 31, 40, 45, 59. Congressional Cotton Seed Distribution Leaflets for 1905 and 1906. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

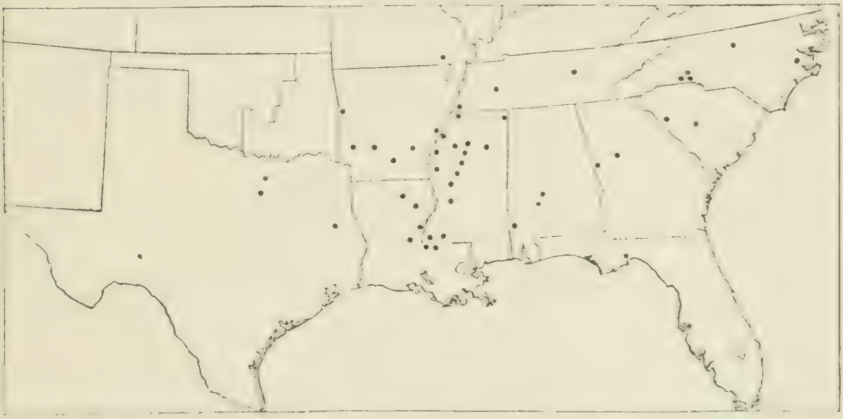

FIG. 54.—Map of the cotton-growing States, showing the distribution of Southern Hope cotton in cultivation, as reported in 1907.

An old variety developed by Col. F. Robiew, of Louisiana. Plant tall, slender in growth, with 1 to 3 limbs, fruiting branches quite long and slender, leaves medium to small; bolls medium in size, opening well and cotton easy to pick; seeds fuzzy, light greenish gray. The sample from which the following measurements were obtained was grown at the Louisiana station, Baton Rouge, La.

Bolls per pound, 73; seeds per pound, 4,160; average length of lint, 31.2 mm. ($1\frac{7}{32}$ inches), varying from 27 to 34 mm.; per cent of lint, 31.2.

Southern Wonder. Big-Boll Group.

Alabama Bulletins 138, 140. Georgia Bulletin 70.

Not now grown. It was developed by L. F. Greer, Oxford, Ala.

Spearman's Choice. Big-Boll Group.

Georgia: Walton County.

Alabama Bulletin 140. Georgia Bulletin 70.

A strain of Dongola developed by W. B. Spearman, Social Circle, Ga. Plant similar to Dongola. Bolls large, lint short, percentage very good.

Bolls per pound, 53; seeds per pound, 3,840; average length of lint, 21.8 mm. ($\frac{7}{8}$ inch), varying from 19 to 24 mm.; average strength of single fibers, 6.2 gms.; per cent of lint, 40.4.

Speight, or Speight's Prolific. BIG-BOLL GROUP.

North Carolina: Greene and Pitt counties.

Alabama Bulletin 140. North Carolina State Board of Agriculture Bulletin for September, 1906.

Developed by J. B. Speight, Winterville, N. C. Plant pyramidal in shape, limbs 1 to 3, fruiting branches $2\frac{1}{2}$ feet long at base of plant to 6 inches in length at top, joints of medium length, bolls large, lint short, seeds fuzzy, light greenish gray.

Bolls per pound, 58; seeds per pound, 3,780; average length of lint, 22.8 mm. ($\frac{29}{32}$ inch), varying from 21 to 24 mm.; strength of single fibers, 6.4 gms.; per cent of lint, 34.2.

Spencer. BIG-BOLL GROUP.

Alabama: Hale County.

Developed by W. M. Spencer, Gallion, Ala. Plant not seen. Bolls large; lint of medium length, percentage good; seeds large, fuzzy, light brownish gray.

Bolls per pound, 47; seeds per pound, 3,065; average length of lint, 25.3 mm. (1 inch), varying from 22 to 29 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 35.4.

Spotted-Bloom.

King, or Sugar-Loaf, is grown in Pope County, Ark., under the above name.

Spruiell's Green-Seed. EARLY GROUP.

(Also known as Spruiell's Early, Spruiell's Reimproved, and Spruiell's Prolific.)

Alabama: Blount, Butler, Conecuh, Coosa, Dekalb, Jefferson, Lamar, Lee, Marion, Shelby, St. Clair, Talladega, and Walker counties.

Arkansas: Monroe County.

Florida: Jackson County.

Georgia: Carroll, Early, Spaulding, and Telfair counties.

Mississippi: Claiborne and Jones counties.

Missouri: Oregon County.

North Carolina: Moore County.

Oklahoma: Roger Mills County.

Tennessee: Obion County.

Texas: Kendall County.

Alabama Bulletins 107, 140. Georgia Bulletin 47.

Developed by A. M. Spruiell, Brompton, Ala. Plants not uniform, some as early as King, others later in maturity. Bolls medium in size, seeds small. The following measurements were obtained from a sample grown by the Alabama station in 1907:

Bolls per pound, 72; seeds per pound, 4,220; average length of lint, 23.5 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; per cent of lint, 32.8.

Station Hybrid.

Mississippi Bulletin 62; Twelfth and Thirteenth Annual Reports.

Not now grown.

Stearns. UPLAND LONG-STAPLE GROUP.

(Also known as Ozier Stearns, Ozier Long-Staple, and Ozier Silk.)

Arkansas: Hempstead and Jefferson counties.

Georgia: Dekalb and Early counties.

Mississippi: Holmes, Sunflower, Warren, and Wilkinson counties.

South Carolina: Bamberg County.

Alabama Bulletin 140. Arkansas First and Second Annual Reports. Mississippi Third Annual Report. North Carolina Tenth Annual Report. South Carolina Bulletin 1, old series; First and Second Annual Reports.

A long-staple variety developed in the Delta region of Mississippi. Plants rather tall, slender, pyramidal in shape, limbs often absent, fruiting branches of medium length, leaves small to medium in size; bolls small, lint fine and soft, of good length, but very low in percentage; seeds fuzzy, gray.

Bolls per pound, 95; seeds per pound, 3,600; average length of lint, 35 mm. ($1\frac{3}{8}$ inches); strength of single fibers, 3.6 gms.; per cent of lint, 24.3.

Stedevan.

Reported only from Henderson County, Tex. Not tested. Originator unknown.

Steegall.

Reported only from Hinds County, Miss. Not tested. Originator unknown.

Sterling. SEMICLUSTER GROUP.

Georgia: Butts County.

Texas: Throckmorton County.

Alabama Bulletin 140. Georgia Bulletin 59.

Developed by Lee W. Dance, Eatonton, Ga. Plants not uniform, about 80 per cent quite closely clustered, the rest ranging from semicluster to open in growth, bolls small, lint of medium length, seeds fuzzy, light brownish gray.

Stevens. BIG-BOLL GROUP.

Georgia: Carroll and Jenkins counties.

Originator unknown. Bolls large, seeds medium in size; lint short, percentage very good.

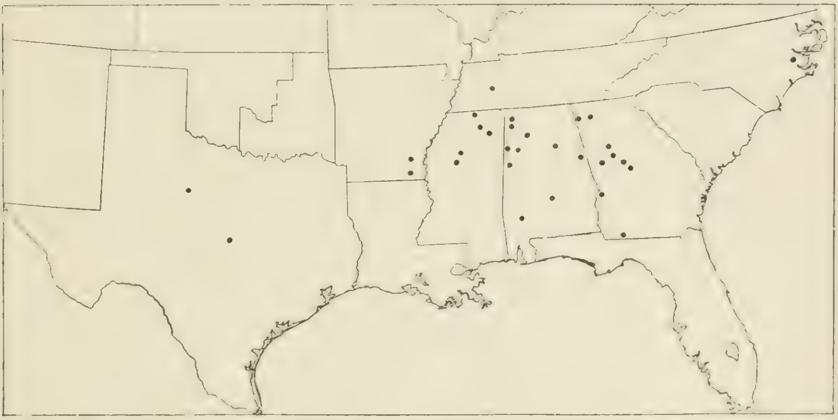

FIG. 55.—Map of the cotton-growing States, showing the distribution of Strickland cotton in cultivation, as reported in 1907.

Stevens, or Stephens Five-Lock. BIG-BOLL GROUP.

Reported from Creek Nation, Oklahoma.

A large-boll variety, probably stormproof, which was developed by selection by E. M. Stevens, of Morse, Okla.; lint of good length, per cent about 34.

Stocks. EARLY GROUP.

Alabama: Fayette and Tuscaloosa counties.

Originator unknown. It is said to be a medium-boll, early-maturing variety yielding a good percentage of lint.

Stolen. PETERKIN GROUP.

Georgia: Heard County.

South Carolina: Sumter County.

A strain of Peterkin said to have been developed by Joseph Jackson, Corinth, Ga. Plant similar to Peterkin, bolls rather small, cotton hard to pick; per cent of lint, nearly 40.

Strickland. BIG-BOLL GROUP.

Distribution: See map, figure 55.

Alabama Bulletins 101, 107, 138, 140. Georgia Bulletins 35, 39, 43, 47, 52, 56, 63, 66. Mississippi Bulletins 62, 79; Twelfth, Thirteenth, and Fifteenth Annual Reports. Texas Bulletin 50. Congressional Cotton Seed Distribution Leaflet for 1905.

Developed by J. R. Strickland, formerly of Tuscaloosa, Ala. As tested by this Department, Strickland proved to be a strain of Wyche. Dwarf and stocky in growth, limbs heavy, 1 to 3 in number, fruiting branches with medium to large joints; bolls very large; lint of medium length; seeds fuzzy, gray.

Bolls per pound, 45 to 50; seeds per pound, 3,000; average length of lint, $\frac{7}{8}$ inch; strength of single fibers, 4.6 gms.; per cent of lint, 32.

Stubbs Double-Jointed. PETERKIN GROUP.

Reported only from Marlboro County, S. C.

A strain of Texas Wood developed by selection by P. S. Stubbs, Clio, S. C. Plant similar to Texas Wood; bolls medium to small; lint short, percentage very high; seeds small, mostly fuzzy, greenish or brownish gray.

Bolls per pound, 82; seeds per pound, 6,060; average length of lint, 19.7 mm. ([illegible] inch), varying from 17 to 22 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 41.2.

Sugar-Loaf. EARLY GROUP.

(Also known as King, King's Early, King's Improved, T. J. King, King's No. 1, King's No. 2, Mascot, Greer, Spotted-Bloom, Ninety-Day, Little Texas, and Little Sugar-Loaf.)

North Carolina: Alamance, Chatham, Franklin, Granville, Guilford, Vance, Wake, and Warren counties. Also see map under King.

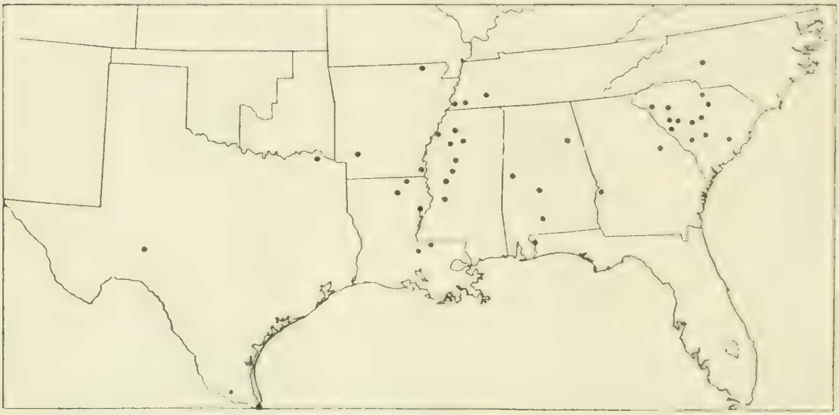

FIG. 56.—Map of the cotton-growing States, showing the distribution of Sunflower cotton in cultivation, as reported in 1907.

Reports of the Patent Office for 1848 and 1850. Report of the Commissioner of Agriculture for 1866.

An old variety which has been grown in North Carolina for many years. The originator is unknown, as is also the date of its introduction. Under this name it has not until recently been known outside of the State, but as "King's Improved" it has probably been grown in every county in the cotton belt. Sugar-Loaf is one of the earliest cottons known; the yield is good on rich land, but it is not as suitable for poor and droughty soil as the Peterkin varieties. The cotton must be picked soon after opening or it wastes badly, this together with its small bolls tending to make it unpopular in Texas. The variety and its derivatives are characterized by the spotted blooms, they being the only Upland cottons grown in the United States, outside of experimental plats, with red or purple spots at the base of the petals.

Plants slender, limbs 1 to 3, fruiting branches slender and short jointed, but with little or no tendency to semicluster; leaves medium to small in size, quite deeply lobed; flowers creamy white with or without red petal spots; bolls small, 3, 4, and 5 locked, the majority 4-locked; lint short; seeds small, covered with a short fuzz, brownish gray in color. The following measurements were obtained from a sample of Sugar-Loaf grown at the Louisiana Experiment Station at Baton Rouge, and a sample of King grown at Auburn, Ala. Unfortunately the King grown at Baton Rouge was impure and could not be used for purposes of comparison.

Bolls per pound, Sugar-Loaf 93, King 94½; seeds per pound, Sugar-Loaf 5,600, King 5,000; average length of lint, Sugar-Loaf 23.3 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm., King 22 mm. (⅞ inch), varying from 20 to 23 mm.; per cent of lint, Sugar-Loaf 35, King 35.7.

Sullivan, or Sullivan Improved Big-Boll.

South Carolina Bulletin 120.

Not now grown.

Sunflower. UPLAND LONG-STAPLE GROUP.

Distribution: See map, figure 56.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 75, 79. Congressional Cotton Seed Distribution Leaflets for 1904 and 1906.

A standard variety introduced by Marx Schaefer, Yazoo City, Miss., who states that he obtained some seed of unknown origin from an oil mill some years ago. The crop resulting from this planting proved to be an excellent long-staple cotton, which he named Sunflower. This variety is not entirely distinct from other long-staple cottons, as has been stated, but belongs to the Southern Hope type and is barely distinguishable from pure Floradora and some of the forms of Allen.

Plant tall and pyramidal, with a slight tendency toward the semicluster habit; limbs 1 to 3, upright in growth, or often absent entirely; fruiting branches slender, growing outward and a little ascending, about 2 feet long at the base and somewhat irregularly jointed, 2 to 3 inches long at the top and very irregularly jointed; leaves medium in size; bolls small, 39 per cent 5-locked, opening fairly well; lint very fine, long, and silky, percentage low; seeds medium in size, fuzzy, gray or light greenish gray. The following measurements were obtained from a sample grown by Mr. Schaefer in 1907:

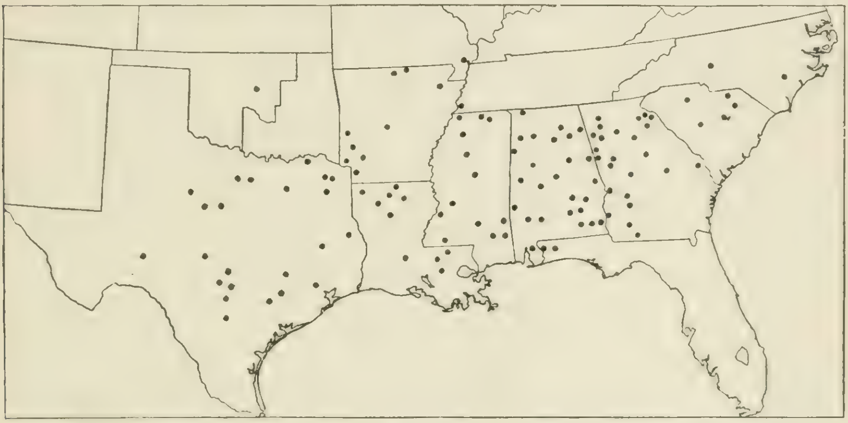

FIG. 57.—Map of the cotton-growing States, showing the distribution of Sure-Crop cotton in cultivation, as reported in 1907.

Bolls per pound, 90; seeds per pound, 4,320; average length of lint, 35.3 mm. (1⅜ inches), varying from 33 to 38 mm.; strength of single fibers, 4.9 gms.; per cent of lint, 25.

Supak. BIG-BOLL STORMPROOF GROUP.

See Bohemian.

Sure-Crop. BIG-BOLL GROUP.

(Also known as Hasting's Sure-Crop and Oliver's Sure-Crop.)

Distribution: See map, figure 57.

This variety is said to have been developed by T. W. Oliver, Georgetown, Ga.

Plants of medium size with a tendency toward the semicluster habit, the joints of the fruiting branches being especially short and irregular toward the ends; bolls medium to large; seeds gray or greenish gray, fuzzy.

Oliver Sure-Crop has not been tested, but a strain sold by the Hastings Seed Company, of Atlanta, Ga., was tested by the Department of Agriculture in Texas, and the following measurements obtained:

Bolls per pound, 76; seeds per pound, 3,780; average length of lint, 22 mm. ($\frac{7}{8}$ inch); strength of single fibers, 5 gms.; per cent of lint, 29.5.

Sure-Crop [Gilbert's]. EARLY GROUP.

Georgia Bulletin 56.

Developed by D. H. Gilbert, Monticello, Ga., and tested by the Georgia station in 1902, with the following results:

Bolls per pound, 82; seeds per pound, 5,000; per cent of lint, 31.6.

Sure-Crop [Simpson's].

A local variety developed by H. L. Simpson, of Tallapoosa County, Ala. Its distribution is confused with Hasting's Sure-Crop, but it is probably not grown outside of this county.

Tarror.

Report of the Patent Office for 1848.

An old variety not now grown.

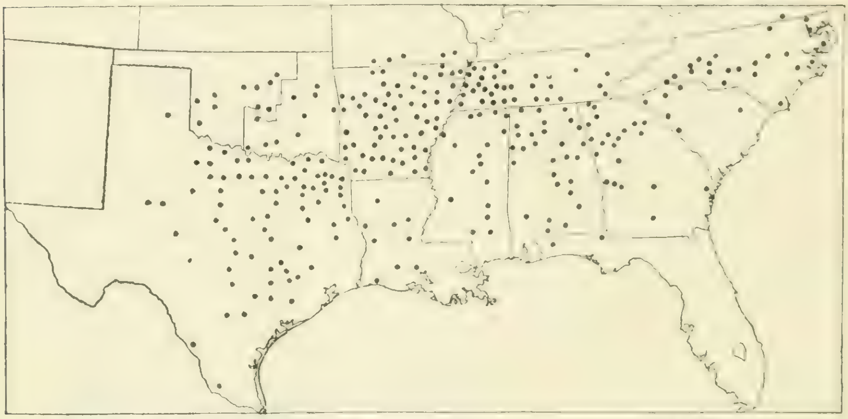

FIG. 58.—Map of the cotton-growing States, showing the distribution of Tennessee Green-Seed cotton in cultivation, as reported in 1907.

Tarver.

Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Formerly grown quite extensively in Dallas County, Ala. Not reported in 1907.

Tatum. BIG-BOLL GROUP.

(Also known as Tatum's Big-Boll and Tatum's Improved.)

Alabama Bulletin 140. Georgia Bulletin 70. Mississippi Bulletin 98.

Developed by R. D. Tatum, Palmetto, Ga. A large-boll cotton with a tendency to become semiclustered. Plant stocky in growth, limbs 1 to 3, fruiting branches short and irregularly jointed, leaves large; bolls large, 4 and 5 locked; percentage of lint good; seeds large.

Bolls per pound, 50½; seeds per pound, 3,065; average length of lint, 23 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 5.4 gms.; per cent of lint, 34.2.

Tennessee Green-Seed. EARLY GROUP.

(Also known as Tennessee Gold-Dust.)

Distribution: See map, figure 58.

Georgia Bulletins 16, 20. Louisiana Bulletins 16, 17, 21, 22, 28, 29, 35. Mississippi Bulletins 18, 23, 62; Third, Fourth, Sixth, and Eighth Annual Reports. North Carolina Bulletin 146. Texas Bulletins 34, 45, 50.

Originator unknown. An early cotton resembling King, but not identical with it. One of the oldest varieties in cultivation. Plants slender in growth, with 1 to 3 limbs and slender fruiting branches, joints of medium length, with little or no tendency to semicluster; leaves medium in size, softly hairy, lobes quite pronounced; flowers creamy white, without petal spots; bolls small, 3, 4, and 5 locked, opening widely and allowing the cotton to waste badly during storms; lint short; seeds small, fuzzy, green or brownish gray.

Bolls per pound, 85; seeds per pound, 4,530; average length of lint, 22 mm. (⅞ inch); strength of single fibers, 6.2 gms.; per cent of lint, 30.5.

Tennessee Silk.

Arkansas Third Annual Report.

Louisiana Bulletins 13, 21, 22, old series; 8, 16, new series.

Not now grown. Tested some years ago by the Louisiana station, with the following results:

Bolls per pound, 86; seeds per pound, 3,975; per cent of lint, 28.4.

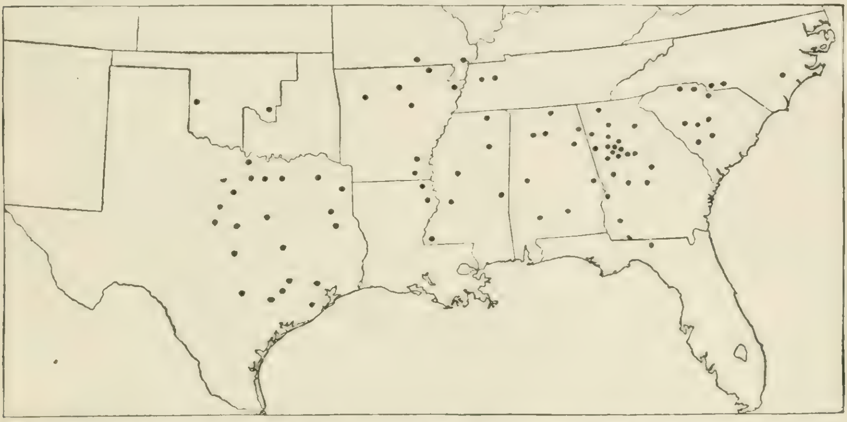

FIG. 59.—Map of the cotton-growing States, showing the distribution of Texas Bur cotton in cultivation, as reported in 1907.

Texas Bur. BIG-BOLL STORMPROOF GROUP.

Distribution: See map, figure 59.

Alabama Bulletins 107, 130, 138, 140. Georgia Bulletins 39, 43, 47, 52, 56, 59, 63, 66, 70, 75, 79. Louisiana Bulletins 62, 71. Mississippi Bulletins 62, 79, 83, 98; Twelfth, Thirteenth, and Fifteenth Annual Reports. South Carolina Bulletin 120.

C. E. Smith, Locust Grove, Ga., is the introducer of this cotton, which is probably a strain of the old Texas Stormproof. It is usually mixed to quite an extent with some of the eastern big-bolls, which impairs its stormproof qualities.

Plants stocky in growth, limbs usually 2, rather heavy; fruiting branches with joints of medium length; leaves large; bolls large, 4 and 5 locked; lint of medium length, percentage good; seeds rather large, fuzzy, gray or brownish gray.

The following measurements were obtained from a sample grown at the Georgia station in 1907:

Bolls per pound, 67½; seeds per pound, 3,680; average length of lint, 23.3 mm. (-15/16 inch), varying from 22 to 26 mm.; strength of single fibers, 7 gms.; per cent of lint, 37.1.

Texas Oak. PETERKIN GROUP.

Distribution: See map, figure 60.

Alabama Bulletins 89, 101, 107, 140. Alabama (Canebrake) Bulletin 18. Georgia Bulletins 35, 39, 43, 47. South Carolina Bulletins 42, 120. Texas Bulletins 40, 45, 50.

A synonym of Peterkin.

Texas Shoe-Heel. BIG-BOLL GROUP.

Originator unknown. A local variety grown in Anson County, N. C., and described as a big-boll cotton yielding about 35 per cent of lint. The seed came originally from Texas, and the name is possibly a corruption of Shoepock, one of the names by which Bohemian is known in Texas. Not tested.

Texas Stormproof. BIG-BOLL STORMPROOF GROUP.

(Also known as Texas Storm and Drought Proof.)

Distribution: See map, figure 61.

Alabama Bulletins 22, 33, 34, 40, 56, 76, 107, 140. Alabama Canebrake Bulletins 11, 14. Georgia Bulletins 11, 16. Louisiana Bulletins 7, 8, 16, 17, 21, 22, 28, 29, 47. Mississippi Bulletins 18, 23, 62; Third, Fourth, Sixth, and Eighth Annual Reports. Oklahoma Bulletin 23. South Carolina Bulletins 1, old series; 42, 120, new series; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety introduced many years ago by W. J. Smilie, of Baileyville, Tex. It is related to Bohemian and Myers, but is less valuable now, as it is badly mixed with other cottons and the stormproof character is considerably impaired.

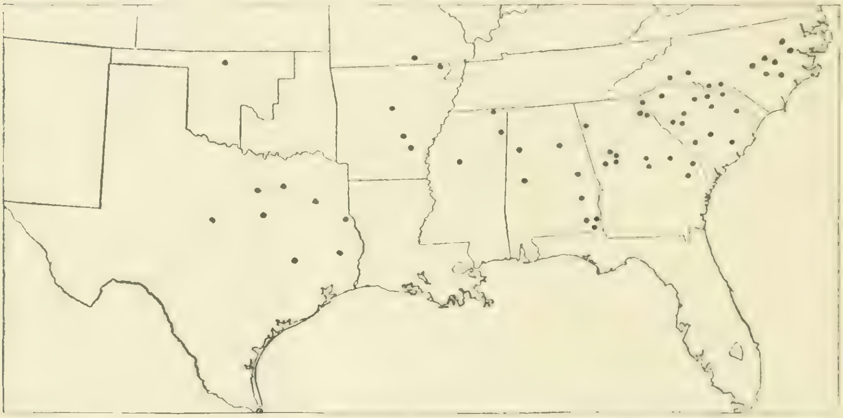

FIG. 60.—Map of the cotton-growing States, showing the distribution of Texas Oak cotton in cultivation, as reported in 1907.

Plants large growing; limbs 1 to 3, heavy; fruiting branches of medium length, joints rather long, leaves large; bolls large, bracts of the involucre very large, cotton held well in the boll, which turns downward when full grown; lint of medium length; seeds large, fuzzy, gray.

Bolls per pound, 55; seeds per pound, 3,475; average length of lint, 24.5 mm. ($\frac{15}{16}$ inch); strength of single fibers, 6.6 gms.; per cent of lint, 31.7.

Texas White Wonder. BIG-BOLL STORMPROOF GROUP.

Arkansas: Franklin, Hempstead, and Lafayette counties.

South Carolina: Lancaster County.

Texas: Donley, Fannin, Fisher, Franklin, Freestone, Grayson, Lamar, Mills, Montague, Palo Pinto, Parker, Reeves, Roberts, Rusk, and Wood counties.

A strain of Bohemian developed by D. Y. McKinney, Grande Prairie, Tex. Plant similar to Bohemian; bolls large, the majority 5-locked; lint of good length; seeds medium in size, fuzzy, gray or brownish gray.

Bolls per pound, 67½; seeds per pound, 4,160; average length of lint, 27 mm. ($1\frac{1}{16}$ inches); strength of single fibers, 6 gms.; per cent of lint, 36.2.

Texas Wood. PETERKIN GROUP.

Distribution: See map, figure 62.

Alabama Bulletins 107, 140. Mississippi Second, Third, and Eighth Annual Reports. North Carolina State Board of Agriculture Bulletin for September, 1906.

South Carolina Bulletin 2; First Annual Report. Congressional Cotton Seed Distribution Leaflet for 1905. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A synonym of Peterkin.

Texas Wool. PETERKIN GROUP.

South Carolina Bulletin 120.

Peterkin cotton is grown locally in Barnwell County, S. C., under this name, probably a corruption of Texas Wood.

Texas Wool.

A remarkable variety, yielding green lint, was sent to the Department of Agriculture some years ago from one of the Eastern States. It was labeled "Texas Wool," but no history of its origin was obtained. This cotton was grown in our variety tests for several years, but seemed to have no commercial value and was discarded.

Plant spreading in growth, limbs 1 to 3, fruiting branches long, not at all semi-clustered, joints medium in length; leaves medium in size; flowers creamy white, without petal spots; bolls small; lint rather short but soft and silky, weak, green in color, fading to a dull greenish brown where exposed, percentage low; seeds of medium size, fuzzy, deep green in color.

Bolls per pound, 103; seeds per pound, 4,530; average length of lint, 21 mm. ($\frac{7}{8}$ inch); strength of single fibers, 3.5 gms.; per cent of lint, 22.5.

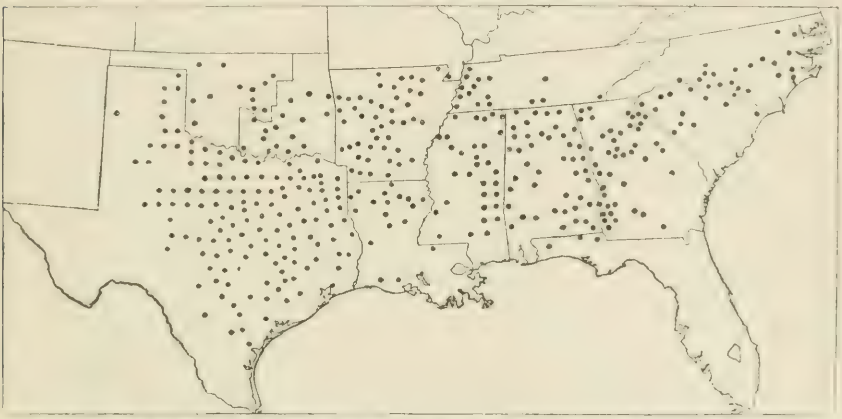

FIG. 61.—Map of the cotton-growing States, showing the distribution of Texas Stormproof cotton in cultivation, as reported in 1907.

Thomas. PETERKIN GROUP..

Arkansas: Yell County.

North Carolina: Anson County.

South Carolina: Cherokee, Chester, Fairfield, Florence, Greenwood, Lexington, Newberry, Richland, Saluda, Spartanburg, Union, and York counties.

South Carolina Bulletin 1, old series; First and Second Annual Reports.

A strain of Peterkin, with possibly a slight admixture of Russell, developed by R. M. Thomas, Alexander City, Ala.

Plant similar to Peterkin; bolls medium in size; lint of medium length, percentage good; seeds dark brown with a tuft of brownish or greenish fuzz at the small end, and usually a very sparse fuzz over the whole seed.

Bolls per pound, 63; seeds per pound, 4,020; average length of lint, 22.6 mm. ($\frac{29}{32}$ inch), varying from 21 to 24 mm.; strength of single fibers, 7.3 gms.; per cent of lint to seed, 36.7.

Thrash's Select. BIG-BOLL GROUP.

(Also known as Thresh's Select and Thrash.)

Alabama Bulletins 107, 140. Georgia Bulletins 39, 43.

Not now grown. Developed by E. C. Thrash, jr., Silvey, Ga., and tested by the Georgia station several years ago, with the following results:

Bolls per pound, 51 to 54; seeds per pound, 2,950 to 3,000; per cent of lint, 30.8 to 33.9.

Todd Early.

Alabama Bulletin 140.

Not now grown.

Todd Improved. BIG-BOLL GROUP.

Arkansas: Faulkner and Lafayette counties.
Georgia: Coweta, Liberty, and Meriwether counties.
Louisiana: Franklin Parish.
Mississippi: Holmes County.
North Carolina: Mecklenburg County.
South Carolina: Greenwood County.

Alabama Bulletin 140. Georgia Bulletins 47, 52, 63, 66.

Developed by selection by P. W. Todd, Grantville, Ga. Plant medium in height, stocky; limbs heavy, usually 2; fruiting branches with joints of medium length, large; bolls very large, 4 and 5 locked; lint of medium length; seeds very large, fuzzy, gray or yellowish gray.

Bolls per pound, 47; seeds per pound, 2,800; average length of lint, 25.5 mm. (1 inch), varying from 24 to 28 mm.; strength of single fibers, 5.9 gms.; per cent of lint, 34.

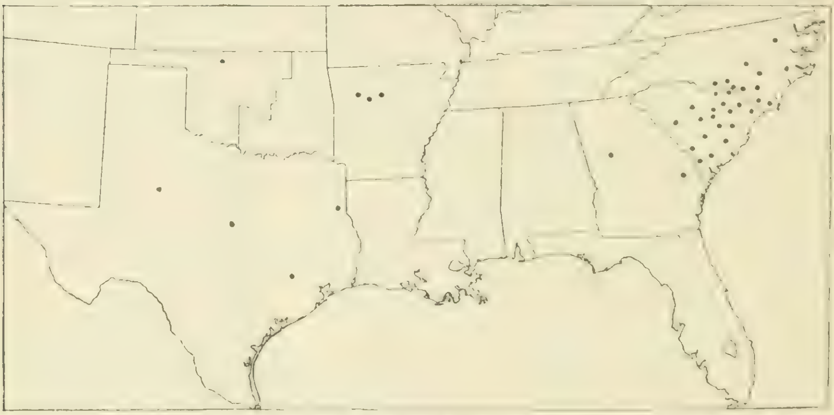

FIG. 62.—Map of the cotton-growing States, showing the distribution of Texas Wood cotton in cultivation, as reported in 1907.

Toole, or Toole Early. PETERKIN GROUP.

Distribution: See map, figure 63.

Alabama Bulletins 130, 138, 140. Georgia Bulletins 66, 70, 79. Mississippi Bulletin 98. North Carolina State Board of Agriculture Bulletin for September, 1906.

A standard strain of Peterkin developed by W. W. Toole, Augusta, Ga., on sandy loam near the Savannah River. It is especially suited to rich, well-cultivated soil, as it does not tend to become "weedy" in growth. Plants similar to Peterkin, but with a slight tendency to semicluster; bolls larger than those of Peterkin, 50 per cent 5-locked; lint of medium length, strong, percentage high; seeds small, fuzzy, light brownish gray.

Bolls per pound, 73; seeds per pound, 5,110; average length of lint, 23.5 mm. ($\frac{15}{16}$ inch), varying from 21 to 26 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 37.5.

Triumph. BIG-BOLL STORMPROOF GROUP.

Distribution: See map, figure 64.

Alabama Bulletin 140. Georgia Bulletin 79. North Carolina State Board of Agriculture Bulletin for September, 1906. Congressional Cotton Seed Distribution Leaflet for 1905.

A standard variety developed by A. D. Mebane, of Lockhart, Tex. Mr. Mebane began about 1897 to select plants in the Boykin Stormproof variety yielding an especially high percentage of lint, and after a few years of careful selection was able to fix this character. The plant is quite similar to Boykin, but earlier in maturity and more inclined to semicluster, the bolls and seeds are somewhat smaller, and the percentage of lint high for a cotton of this group.

Bolls per pound, 56½; seeds per pound, 3,600; average length of lint, 24 mm. ($\frac{15}{16}$ inch), varying from 22 to 27 mm.; strength of single fibers, 6.7 gms.; per cent of lint, 38.1.

Truitt. BIG-BOLL GROUP.

(Also known as Truitt Improved, Truitt Prolific, Truitt Premium, and Truitt Improved Premium Prolific.)

Distribution: See map, figure 65.

Alabama Bulletins 5, 12, 13, 16, 22, 33, 34, 40, 52, 56, 76, 89, 101, 107, 130, 140. Alabama (Canebrake) Bulletins 7, 14, 18; Twelfth and Thirteenth Annual Reports. Alabama (Wetumpka) First Annual Report. Arkansas Bulletin 18; Third Annual Report. Georgia Bulletins 11, 16, 20, 24, 27, 31, 35, 43, 56, 59. Louisiana Bulletins 8, 16, 21, 22, 28, 29, 35, 47, 62, 71. Mississippi Bulletins 18, 23, 62, 84, 88, 98; Second, Third, Fourth, Sixth, Eighth, Twelfth, and Thirteenth Annual Reports. North Carolina Bulletin 146. South Carolina Bulletins 2, 18, 42, 120; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Congressional Cotton Seed Distribution Leaflets for 1902 and 1904. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

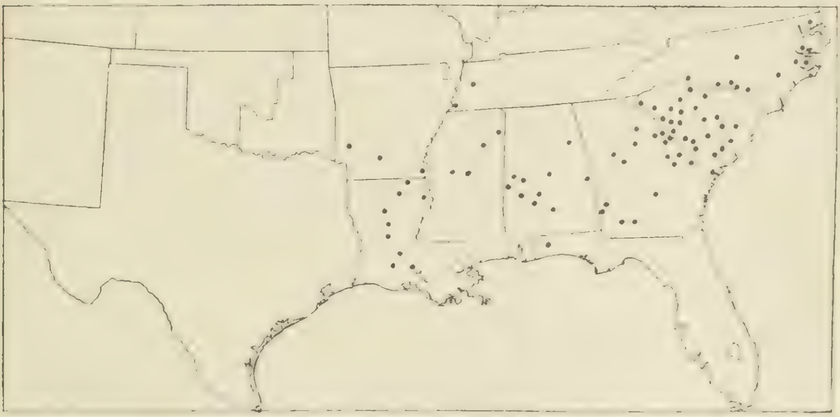

FIG. 63.—Map of the cotton-growing States, showing the distribution of Toole, or Toole Early, cotton in cultivation, as reported in 1907.

A standard variety developed by George W. Truitt, of Lagrange, Troup County, Ga. Mr. Truitt states that he began with the large-boll, white-seed cotton commonly grown at that time and carefully selected the best plants from it for several years until he obtained a prolific, medium-early, big-boll cotton. The parent of Truitt cotton is almost certainly Wyche or one of its derivatives, since these had been grown almost exclusively in Troup County for many years before Mr. Truitt began his selections.

Plants not uniform, about 20 per cent semiclustered in growth; limbs 1 to 3, heavy; fruiting branches medium to long jointed; leaves large; bolls large; lint of medium length; seeds large, fuzzy, gray.

Bolls per pound, 56; seeds per pound, 3,660; average length of lint, 22.9 mm. ($\frac{29}{32}$ inch), varying from 21 to 24 mm.; strength of single fibers, 6.6 gms.; per cent of lint, 34.

Tucker's Long-Staple. UPLAND LONG-STAPLE GROUP.

A local variety grown in Red River County, Tex. Said to have been developed by George Tucker, of that county.

Turner's Improved. BIG-BOLL GROUP.

Georgia Bulletin 39.

Not now grown. Tested by the Georgia station in 1896, with the following results: Bolls per pound, 55; seeds per pound, 2,948; per cent of lint, 31.7.

Turpin. UPLAND LONG-STAPLE GROUP.

Louisiana: Tensas Parish.

See Willis.

Tyler, or Tyler's Limb Cluster. SEMICLUSTER GROUP.

Alabama Bulletins 76, 89, 107, 140. Georgia Bulletins 35, 56. Louisiana Bulletins 35, 47, 62, 71. Mississippi Fifteenth Annual Report. South Carolina Bulletin 120. Texas Bulletins 34, 40, 45, 50.

Not now grown. Originated by K. J. Tyler, of Aiken, S. C., and tested several times by the experiment stations about ten years ago. The following is an average of the results published.

Bolls per pound, 84; seeds per pound, 4,750; length of lint, 1 inch; per cent of lint, 31.2.

Veale. UPLAND LONG-STAPLE GROUP.

Louisiana: West Feliciana Parish.

A strain of Keno developed by C. H. Veale, of Brandon, La. It is stated that the boll is of medium size, the per cent of lint about 28, the length of staple 1$\frac{3}{8}$ inches. Not tested.

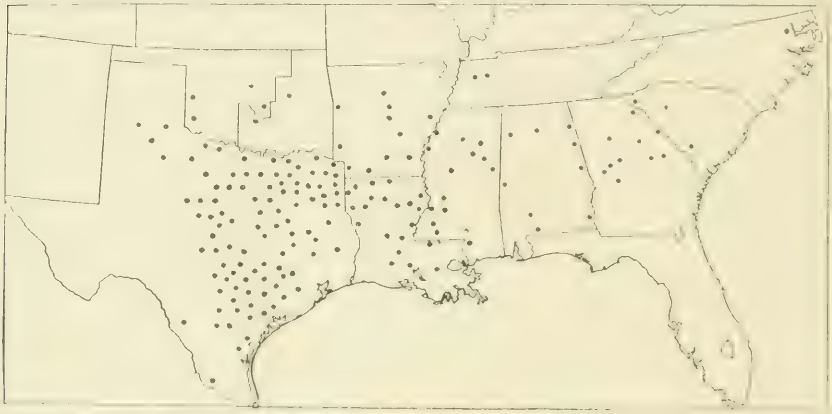

FIG. 64.—Map of the cotton-growing States, showing the distribution of Triumph cotton in cultivation, as reported in 1907.

Vick's 100-Seed.

Reports of the Patent Office for 1848 and 1850. Report of the Commissioner of Agriculture for 1866.

An old variety not now grown.

Victor. BIG-BOLL GROUP.

Alabama Bulletin 140. Georgia Bulletin 66.

Not now grown. Developed by Charles C. Parrott, Newnan, Ga., and tested by the Georgia station in 1903, with the following results:

Bolls per pound, 62; seeds per pound, 3,200; per cent of lint, 34.7.

Waldrop. BIG-BOLL STORMPROOF GROUP.

Reported only from Clark County, Ark.

Robert Waldrop, of Arkadelphia, Ark., states that he first obtained seed of this cotton from southwestern Texas about ten years ago. It is probably a strain of Bohemian or Myers.

Walker. EARLY GROUP.

Georgia: Monroe County.

South Carolina: Greenville County.

Tennessee: Gibson County.

Originator unknown. This variety is described as early in maturity, bolls of medium size, percentage of lint good.

Wallace. BIG-BOLL GROUP.

Texas: Titus County.

A synonym of Cummings.

Walters.

Georgia: Lee and Macon counties.

Developed by the late Doctor Walters, of Montezuma, Ga., and further selected by R. W. Gilbert, R. F. D. No. 3, Montezuma, Ga. The plant is quite similar to Cook's Improved; bolls round, of medium size; percentage of lint high; seeds fuzzy, light brownish gray.

Bolls per pound, 77½; seeds per pound, 4,050; average length of lint 23 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.2 gms.; per cent of lint, 38.1.

Warren. BIG-BOLL GROUP.

Arkansas: Craighead County.

Louisiana: Acadia Parish.

Mississippi: Kemper County.

South Carolina: Darlington County.

Tennessee: Gibson County.

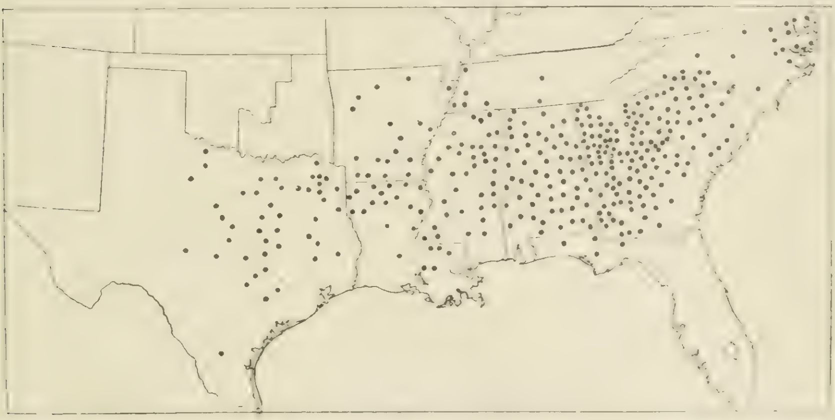

FIG. 65.—Map of the cotton-growing States, showing the distribution of Truitt cotton in cultivation, as reported in 1907.

Alabama Bulletin 140. Mississippi Bulletins 23, 62; Sixth and Eighth Annual Reports.

Developed by J. B. Warren, Ennis, Kemper County, Miss. Warren cotton is intermediate between the Peterkin and big-boll groups.

Bolls per pound, 56; seeds per pound, 4,100; average length of lint, 23.7 mm. ($\frac{15}{16}$ inch), varying from 21 to 27 mm.; strength of single fibers, 7.5 gms.; per cent of lint, 32.9.

Webb's Cluster. PETERKIN GROUP.

North Carolina: Edgecombe, Lenoir, and Nash counties.

Alabama Bulletin 140. North Carolina State Board of Agriculture Bulletin for September, 1906.

Said to have been developed by Garrett Webb, formerly of Edgecombe County, N. C. It is stated to be a cluster or semicluster cotton, early in maturity, and yielding a high percentage of lint.

Webb's Stormproof. BIG-BOLL GROUP.

Alabama Report for 1881 and 1882.

An old variety not now in cultivation. It was tested at the experiment farm of the Agricultural and Mechanical College, Auburn, Ala., about twenty-five years ago and reported upon as follows: "Mr. Webb claims for this cotton that 40 bolls will weigh a pound. This claim was sustained by several weighings." The percentage was found to be 36.93. Webb's Stormproof was developed by W. T. Webb, Alpine, Talladega County, Ala.

Welborn's Pet. CLUSTER GROUP.

(Also known as Welborn's Fancy Pet and Welborn's Improved.)

Distribution: See map, figure 66.

Alabama Bulletins 5, 12, 13, 16, 33, 34, 40, 52, 56, 76, 101, 107, 138, 140. Alabama (Canebrake) Bulletins 7, 11, 14, 18; Twelfth and Thirteenth Annual Reports. Arkansas Bulletin 23; Second Annual Report. Georgia Bulletins 11, 20, 43. Louisiana Bulletins 21, 22, 26, 27, old series; 7, 8, 16, 17, 21, 22, 28, 29, 35, 47, 62, new series; Third Annual Report. Mississippi Bulletin No. 18; Second, Third, and Fourth Annual Reports. North Carolina Bulletin 146. South Carolina Bulletins 2, 18; First and Second Annual Reports. Texas Bulletins 34, 40, 45, 50. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A strict cluster cotton, quite similar to Dickson, developed by the late Jeff Welborn, of New Boston, Tex. Mr. Welborn stated that it originated on the Red River bottoms in Texas, in 1881, by the crossing or blending of Barnes, a dense-growing, broad-leaf, green-seed variety, and Jones Improved, upon Zellner, a very small clustered variety with only two leaves to the cluster of bolls. Welborn's Pet was tested in 1891 along with Zellner and reported as being apparently the same.

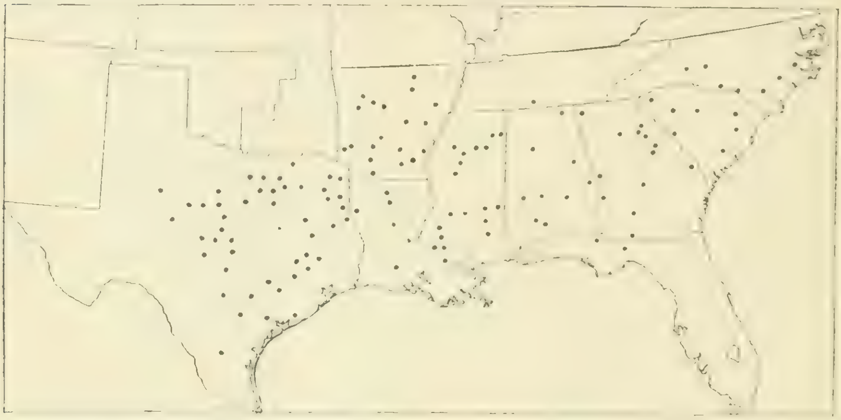

FIG. 66.—Map of the cotton-growing States, showing the distribution of Welborn's Pet cotton in cultivation, as reported in 1907.

Plant tall, limbs 1 to 3; fruiting branches reduced to short spurs, 2 to 3 inches long at the base of the stalk, often somewhat longer in the middle and very short at the upper end; leaves large; bolls rounded, 4 to 5 locked; lint short; seeds medium in size, fuzzy, brownish gray, a few nearly smooth, dark brown.

Bolls per pound, 68; seeds per pound 3,860; average length of lint, 22 mm. ($\frac{7}{8}$ inch), varying from 20 to 24 mm.; per cent of lint, 33.4.

Werner. BIG-BOLL STORMPROOF GROUP.

A local variety grown in Blanco County, Tex., and developed by Joseph Werner, of Blanco, who states that he tested several varieties of cotton and found Myers best suited to that locality. After several years of selection he obtained a strain of Myers which is superior to the mixed seed usually sold under that name.

Plants similar to Myers; bolls large, thoroughly stormproof, but cotton easily picked; per cent of lint 34.5; seeds large, fuzzy, gray.

West. PETERKIN GROUP.

Grown locally in Carroll County, Miss. A strain of Brandon developed by N. C. West, McCarley, Miss. Plant similar to Brandon, bolls medium in size, percentage of lint good, seeds medium in size, fuzzy, yellowish brown or nearly smooth and dark brown.

Bolls per pound, 78; seeds per pound, 4,490; average length of lint, 24.7 mm. ($\frac{31}{32}$ inch), varying from 23 to 28 mm.; strength of single fibers, 7.4 gms.; per cent of lint, 35.5.

Whatley, or Whatley's Improved. BIG-BOLL GROUP.

Alabama Bulletins 52, 76, 89, 107, 140.

Not now grown. Originated by T. A. Whatley, Opelika, Ala.

White. BIG-BOLL STORMPROOF GROUP.

Triumph is grown locally in Waller County, Tex., under this name. R. G. White, of Hempstead, states that he obtained the seed from Mr. Mebane about four years ago and that on his soil the variety has gradually improved in percentage of lint.

White Wonder and White-Lock Wonder. BIG-BOLL STORMPROOF GROUP.

See Texas White Wonder.

White's Improved.

This variety has disappeared from cultivation. It was formerly grown in northern South Carolina and is said to have been originated by A. H. White, Rock Hill, York County, S. C.

Whitten, or Whitten Cluster.

Alabama Bulletin 140.

Not now grown.

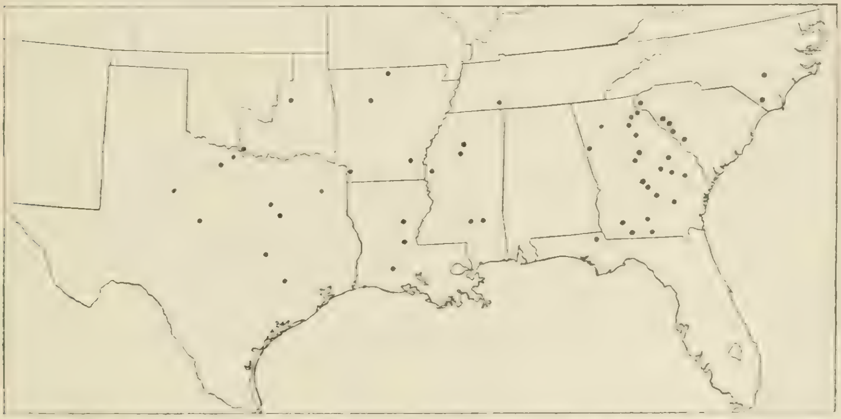

FIG. 67.—Map of the cotton-growing States, showing the distribution of Willet Red-Leaf cotton in cultivation, as reported in 1907.

Wiggs. EARLY GROUP.

North Carolina: Johnston, Lenoir, Sampson, and Wayne counties.

A strain of Sugar-Loaf said to have been developed by George W. Wiggs, Princeton, N. C. It is described as extra early in maturity, bolls medium in size, per cent of lint about 37.

Wilczinski.

Mississippi Bulletin 18; Fourth Annual Report.

Not now grown. Developed by B. F. Gray, Wilczinski, Miss.

Wild. PETERKIN GROUP.

A form of Peterkin, yielding nearly 40 per cent of lint, grown in Jackson County, Ga.

Wilkinson, or Walston Round-Boll.

See Round-Boll.

Willet Red-Leaf.

(Also known as Allen's Red Rustproof.)

Distribution: See map, figure 67.

Alabama Bulletins 130, 138, 140. Alabama (Tuskegee) Bulletin 7. Georgia Bulletin 66. Mississippi Bulletin 87.

A distinct variety of unknown origin introduced by the N. L. Willet Seed Company, Augusta, Ga. Mr. Willet states that it was obtained "from an Illinois garden, used there as an ornamental plant." It seems probable[a] that this variety may have descended, through J. C. Cook and an earlier red-leaved cotton known as "Ben Smith," from the old Purple-Stalk, or Red-Leaf, grown commonly about sixty years ago in Alabama and Georgia.

Plant tall and pyramidal in shape, rather long shanked, the first limbs coming out 6 inches or more from the base of the stalk; limbs 1 to 3; sharply upright in growth; fruiting branches ascending; joints often somewhat irregular in length, showing a tendency to semicluster; leaves medium in size; stem, branches, and leaves dark red; bolls medium in size, dark red except where shaded by the red involucre; glands darker red, almost black; flowers creamy white, handsomely tinted with pink; lint of medium length; seeds fuzzy, greenish or brownish gray. The following measurements were obtained from a sample grown at the Louisiana station (Baton Rouge) in 1907:

Bolls per pound, 68; seeds per pound, 4,230; average length of lint, 25 mm. (1 inch), varying from 23 to 27 mm.; per cent of lint, 35.7.

Willey. UPLAND LONG-STAPLE GROUP.

Arkansas: Lincoln County.

Developed by J. C. Willey, of Cummins, Ark. Not tested.

Williams.

A local variety grown in Warren County, N. C., and said to have been developed by A. D. Williams, Centerville, N. C. Not tested.

Williams's Select. BIG-BOLL GROUP.

Mississippi: Covington and Hinds counties.

North Carolina: Warren County.

Tennessee: Shelby County.

Georgia Bulletin 79. Mississippi Sixth Annual Report. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Developed by J. H. Williams, Luthersville, Ga. Plants quite similar to Russell in habit of growth; limbs 1 to 3, heavy; fruiting branches fairly short jointed, with a tendency to semicluster, 2 feet long at the base of the plant, 3 to 4 inches long at the top; leaves large; bolls large, 48 per cent 5-locked; lint of medium length; seeds large, fuzzy, dark green and brown.

Bolls per pound, 64; seeds per pound, 3,360; average length of lint, 25.4 mm. (1 inch), varying from 24 to 27 mm.; strength of single fibers, 6.5 gms.; per cent of lint, 33.2.

Williamson. BIG-BOLL GROUP.

Mississippi Second and Third Annual Reports. South Carolina Bulletins 1, old series; 2, new series; First and Second Annual Reports.

Developed by E. M. Williamson, Montclare, S. C. Plant not seen. Bolls large, lint of medium length, seeds large, fuzzy, gray or light greenish gray.

Bolls per pound, $54\frac{1}{2}$; seeds per pound, 3,400; average length of lint, 24.1 mm. ($\frac{30}{32}$ inch), varying from 23 to 25 mm.; strength of single fibers, 5.3 gms.; per cent of lint, 32.6.

Willimantic.

Georgia Bulletin 16. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now grown.

Willis. UPLAND LONG-STAPLE GROUP.

Louisiana Bulletins 22, 23, 28, 29; Third Annual Report. Mississippi Bulletins 18, 23, 62; Fourth, Sixth, and Eighth Annual Reports. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

A "staple" cotton developed by the late John B. Willis, of Issaquena County, Miss., and tested by the Mississippi and Louisiana stations sixteen to eighteen years ago. It is still grown by J. Archer Turpin, L'Argent, La., and has been disseminated to some extent in Tensas Parish under the name of "Turpin."

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[a] Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture, pp. 199, 204; also Bulletin 140, Alabama Agricultural Experiment Station.

Willow Bunch.

A local variety formerly and to a less extent still grown in White County, Ark. It is described as an early-maturing variety, with small, long, and sharp-pointed bolls, seeds small, and lint of good length.

Willow Switch. UPLAND LONG-STAPLE GROUP.

A local variety grown in Jefferson County, Ark. It is said to be a very productive "staple" cotton, the lint of good quality and bringing 3 to 4 cents a pound premium. Not tested.

Wilson Matchless. BIG-BOLL GROUP.

Alabama Bulletin 140. Georgia Bulletin 70.

A local variety developed by F. D. Wilson, Chase City, Va., formerly of Littleton, N. C.

Plant not seen. Bolls medium to large, percentage of lint good, seeds large, fuzzy, light brownish gray.

Bolls per pound, 60½; seeds per pound, 3,540; average length of lint, 22.6 mm. ($\frac{57}{64}$ inch), varying from 21 to 23 mm.; strength of single fibers, 6.5 gms.; per cent of lint, 34.4.

Wilson Stormproof. BIG-BOLL STORMPROOF GROUP.

A local variety reported from Coleman and Lamar counties, Tex., and said to have been developed by D. D. Wilson, of Santa Anna, Tex. It is described as being a thoroughly stormproof cotton, somewhat similar to Myers. Not tested.

Wise. PETERKIN GROUP.

Arkansas: Ashley, Bradley, Cleveland, Crawford, Dallas, Drew, Hempstead, Nevada, Ouachita, Phillips, Saline, and Union counties.

Louisiana: Ouachita and Union counties.

Mississippi: De Soto, Holmes, Tallahatchie, Washington, and Yazoo counties.

North Carolina: Columbus County.

Texas: Bowie, Camp, Franklin, and Upshur counties.

Alabama Bulletins 107, 130, 140. Georgia Bulletins 56, 63. South Carolina Bulletin 1, old series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

An old variety usually considered as synonymous with Peterkin. Originator unknown. An average of several tests reported in former years by the southern experiment stations follows:

Bolls per pound, 77; seeds per pound, 5,200; per cent of lint, 37.

There is a higher percentage of smooth black seed in this variety than in the Peterkin of to-day.

Wise County Round-Boll.

A local variety grown in Wichita County, Tex. Not tested.

Wood.

A local variety grown in Chester County, S. C., and said to have been developed by J. C. Wood, R. F. D. No. 1, Calvin, S. C. Not tested.

Wood's Improved. PETERKIN GROUP.

Alabama: Henry County.

A selection from Hard-Shell made by Samuel Wood, Abbeville, Ala., who states that it is entirely wiltproof. Bolls medium in size, percentage of lint good, seeds small, fuzzy, brownish gray.

Bolls per pound, 78; seeds per pound, 4,920; average length of lint, 22.8 mm. ($\frac{57}{64}$ inch), varying from 22 mm. to 24 mm.; strength of single fibers, 5.8 gms.; per cent of lint, 35.

Woodall. BIG-BOLL STORMPROOF GROUP.

Texas: Collin, Comanche, Fannin, and Limestone counties.

Developed by Jot Woodall, R. F. D. No. 2, Farmersville, Tex. Mr. Woodall states that he first obtained the seed from a tenant who moved to Collin County from some part of the Brazos Valley and who brought this seed with him. After selecting seed from the best plants to be found for some years Mr. Woodall obtained a strain of stormproof cotton which has become very popular in some parts of Texas. It is said to be 8 to 10 days earlier than Rowden, but with bolls quite as large. It has, unfortunately, become somewhat mixed with other varieties.

Plant very similar to Rowden, stocky in growth, limbs 1 to 3, usually 2; fruiting branches medium short jointed, drooping; leaves medium to large; bolls large, the majority 5-locked, turning downward at maturity; lint of medium length; seeds fuzzy, gray in color.

Bolls per pound, 60; seeds per pound, 3,220; average length of lint, 24.8 mm. ([illegible] inch), varying from 23 to 27 mm.; strength of single fibers, 7.3 gms.; per cent of lint, 34.9.

Woodfin Prolific.

See Nonpareil.

World's Wonder. SEMICLUSTER GROUP.

A trade name for Drake Defiance, which see.

Wyche. BIG-BOLL GROUP.

Georgia: Meriwether and Pike counties.

Alabama Bulletin 140. Georgia Bulletin 70.

An old variety, the parent of many of the most popular big-boll cottons of the Eastern States, and more or less grown all over the cotton belt under the trade name of "Mortgage Lifter." J. S. Wyche, of Oakland, Ga., the originator of this cotton, states that over thirty years ago he found a single plant in his field of small-boll cotton which bore very large 5-locked bolls. It was the first large-boll cotton he had seen, and he picked the seed separately and in a few years planted his entire crop with this variety. It became very popular throughout that region, and the seed was rapidly disseminated by Mr. Wyche and others, especially Warren Beggerly, of Coweta County, and J. H. Jones, of Troup County.

Plant strong and vigorous in growth; limbs large, usually 2 in number; fruiting branches with joints medium to rather long; leaves large; bolls large, the majority 5-locked, not as immune to insect injury as those of Russell; lint of medium length and percentage; seeds large, fuzzy, gray or light brownish gray.

Bolls per pound, 45½; seeds per pound, 2,840; average length of lint, 23 mm. ($\frac{29}{32}$ inch), varying from 22 to 25 mm.; strength of single fibers, 6.4 gms.; per cent of lint, 32.

Yellow.

See Nanking.

Zaney Improved.

A local variety grown in Abbeville County, S. C. Not tested.

Zellner. CLUSTER GROUP.

Alabama Bulletins 5, 12, 13, 16, 33, 40, 56, 107, 140; Report for 1881–82. Alabama (Canebrake) Bulletins 7, 11, 14. Louisiana Bulletin 26, old series. Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture.

Not now cultivated. The following note on its origin is taken from the Report of the Trustees of the State Agricultural and Mechanical College, Auburn, Ala., 1881–82, page 53:

"Doctor Zellner, of Ashville, St. Clair County, Ala., has for several years been improving his cotton by yearly selections. His efforts have been so successful as to merit for this improved cotton the name of Zellner cotton. Several hundred bushels of his seeds have been purchased by the Agricultural Department at Washington and distributed among the planters of the South."

Zellner was one, and certainly the most important one, of the parent stocks of Welborn's Pet. It was described[a] as very much like Dickson.

Zephyr.

A local variety formerly grown in Anson and Lincoln counties, N. C.

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[a] Bulletin 33, Office of Experiment Stations, U. S. Dept. of Agriculture, p. 210.

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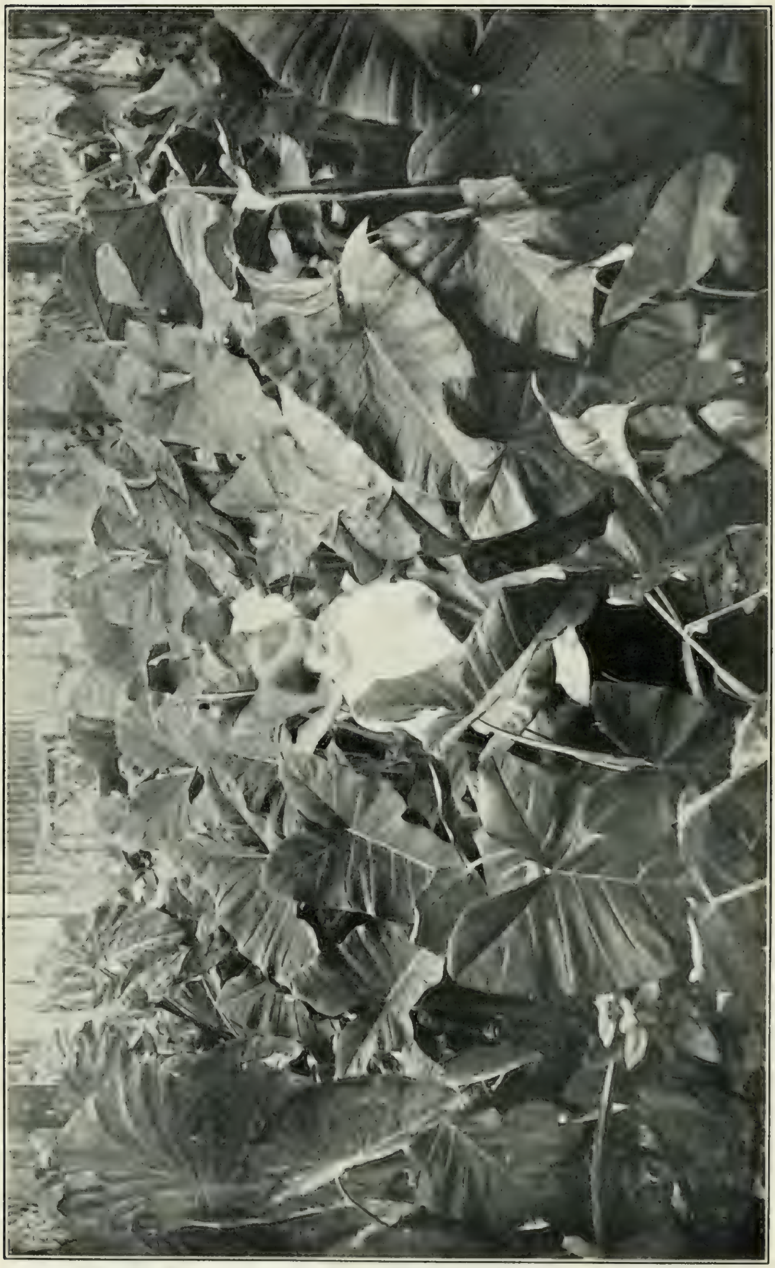

A Collection of Yautias (Xanthosoma spp.) Growing at Gotha, Fla.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 164.

B. T. GALLOWAY, *Chief of Bureau.*

PROMISING ROOT CROPS FOR THE SOUTH.

I.—YAUTIAS, TAROS, AND DASHEENS.

BY

O. W. BARRETT,

Plant Introducer, Office of Foreign Seed
and Plant Introduction.

II. AGRICULTURAL HISTORY AND UTILITY OF THE CULTIVATED AROIDS.

BY

O. F. COOK.

Issued February 5, 1910.

239489
13130

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D.C., September 15, 1909.

Sir: I have the honor to transmit herewith a manuscript entitled "Promising Root Crops for the South," consisting of two papers, "Yautias, Taros, and Dasheens," and "The Agricultural History and Utility of the Cultivated Aroids," and to recommend that it be published as Bulletin No. 164 of the Bureau series. These papers have been prepared by Mr. O. W. Barrett, formerly Plant Introducer, Office of Foreign Seed and Plant Introduction, and Mr. O. F. Cook, Bionomist, with a view to publication.

Mr. Barrett, who recently resigned his position in this Bureau to take up the organization of a department of agriculture in the colony of Portuguese East Africa, both before and after his connection with the Department of Agriculture, spent much time in investigating the possibilities of a group of plants that has been almost completely neglected by plant cultivators unfamiliar with the Tropics—yautias, taros, and dasheens. These root crops have formed the staple food of such native races as the Hawaiians in the Pacific, and they have played important rôles in the agriculture of China, Japan, and the Malay Archipelago; in fact, taking the Tropics as a whole, they are among the most important of all root crops.

Mr. Barrett has long believed that the yautias, dasheens, and other members of the group belonging to the family Araceæ could be cultivated with profit in the southern United States, and in order to find out what might be expected of the different varieties in this country, he assembled a large collection from different parts of the world. His practical experience with similar collections in Porto Rico encouraged him to recommend these as new root crops for the South.

This report was prepared rather hurriedly before Mr. Barrett's departure for East Africa. It contains the information which Mr. Barrett had collected regarding the different species and varieties, and its object is to enable persons unfamiliar with the plants to distinguish the different sorts, some of which are likely to be much more valuable than others.

A general chapter on the agricultural history and utility of the cultivated aroids has been prepared by Mr. O. F. Cook, who has been acquainted with these plants in tropical countries.

The collection of varieties of cultivated aroids assembled by Mr. Barrett is now being propagated at Gotha, Fla., in cooperation with Mr. H. Nehrling, and as soon as a sufficient stock of the different varieties is on hand small experiments with them will be started at different places in the South.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—512.

PROMISING ROOT CROPS FOR THE SOUTH.

I.—YAUTIAS, TAROS, AND DASHEENS.

By O. W. Barrett, *Plant Introducer, Office of Foreign Seed and Plant Introduction.*

INTRODUCTION.

For many years the lack of a wet-land root crop has been felt throughout the South Atlantic and Gulf States. In view of the fact that some 40,000 acres in the Carolinas and Georgia have been fully abandoned, with at least half as much ground that is only planted once in two to four years on account of the decreased profits in rice culture in that section, an effort has been made to find profitable crops which may be grown in the rich soils of the coast-plain area of both of the regions mentioned, which are too wet for profitable potato culture.

The recent increase of interest in starch roots, which may be utilized in the production of alcohol as well as for stock feeding, has lent a still greater importance to this question.

With one or two exceptions the root crops discussed in the following pages are practically new to this country and come from the Tropics. However, their crop season is sufficiently short to allow of their maturing in ordinary seasons before the advent of killing frosts; in fact, one or two of the varieties have been successfully grown with a fair yield as far north as central New York.

These crops comprise salad plants, table tubers, stock-feed tubers, starch roots, and varieties adapted for the manufacture of meal, alcohol, etc.

GENERAL DESCRIPTION OF YAUTIAS, TAROS, AND DASHEENS.

The economic aroids of the world have received very little attention outside of a few tropical countries, yet some of them bid fair to become of great commercial importance within a few years, for the following reasons: They are adapted to soils which are too wet for other root crops, such as sweet potatoes and cassava; they grow rapidly if given a fairly rich soil and a fair amount of moisture; they yield heavily, in some cases two to four times the average yield of potatoes (the Rolliza yautia[a] has yielded when moderately fertilized, with ordinary cultivation, at the rate of 15 tons of edible tubers, besides 5 tons of rootstocks suitable for stock feeding or starch manufacture); their keeping qualities are in most cases excellent, whether kept in the ground in situ or in a dry place in bags; and they are resistant to insect and fungous pests.

The yautias (see Pl. I), or, as some varieties are called in the British West Indies, taniers, are perhaps more important from the commercial point of view than either the taros or the dasheens. These three types of plants occur throughout the world in from 100 to 200 varieties.

The yautias, or taniers, belong to the genus Xanthosoma, and by far the greater number of forms are included in the species *X. sagittifolium* Schott. (See Pl. II, *B*.) The taros have long been known under the name *Colocasia antiquorum esculentum*; unfortunately, the yautias have been almost always, up to the beginning of the twentieth century, included under this name. The dasheens are tuberous-rooted taros, usually of dwarf habit (see Pl. III, *B*, and Pls. IV and V), and though it is uncertain to what species they belong there is no doubt whatever of their close kinship with the true taros. (See Pl. III, *A*.) The alocasias (see Pl. II, *A*) of the Orient and South America resemble the xanthosomas, but can usually be readily distinguished by their leaf, as well as their root, characters. The genera Xanthosoma, Colocasia, and Alocasia constitute almost the only economic plants in the subfamily Colocasieæ.

The general aspect of the plants belonging to this group is that of the so-called caladium, or elephant-ear, which has become popular as an ornamental during the past two or three decades. They are succulent, stemless plants, although some varieties produce a rhizome, or main rootstock, 2, or even 4, feet in length, the greater portion of which may be above the surface of the ground. The leaves arise from the tip of this rootstock or from its offsets or tubers. The leaf stem ranges from 1 to 8 feet in height; it is usually grooved near the middle, forming a sinus which at its lowest extremity is wrapped about the tip of the rootstock. Most varieties seldom or never produce flowers, and none of the cultivated forms have been observed by the author to produce seed under any circumstances. In fact, the yautias are considered the oldest cultivated crop in the world—and probably the only one, with the exception of the highly cultivated taros—which does not ripen seed under favorable conditions.

The leaf blade of the yautia is always sagittate, or arrow-shaped, i. e., the sinus at the broad base is open, exposing the attachment of

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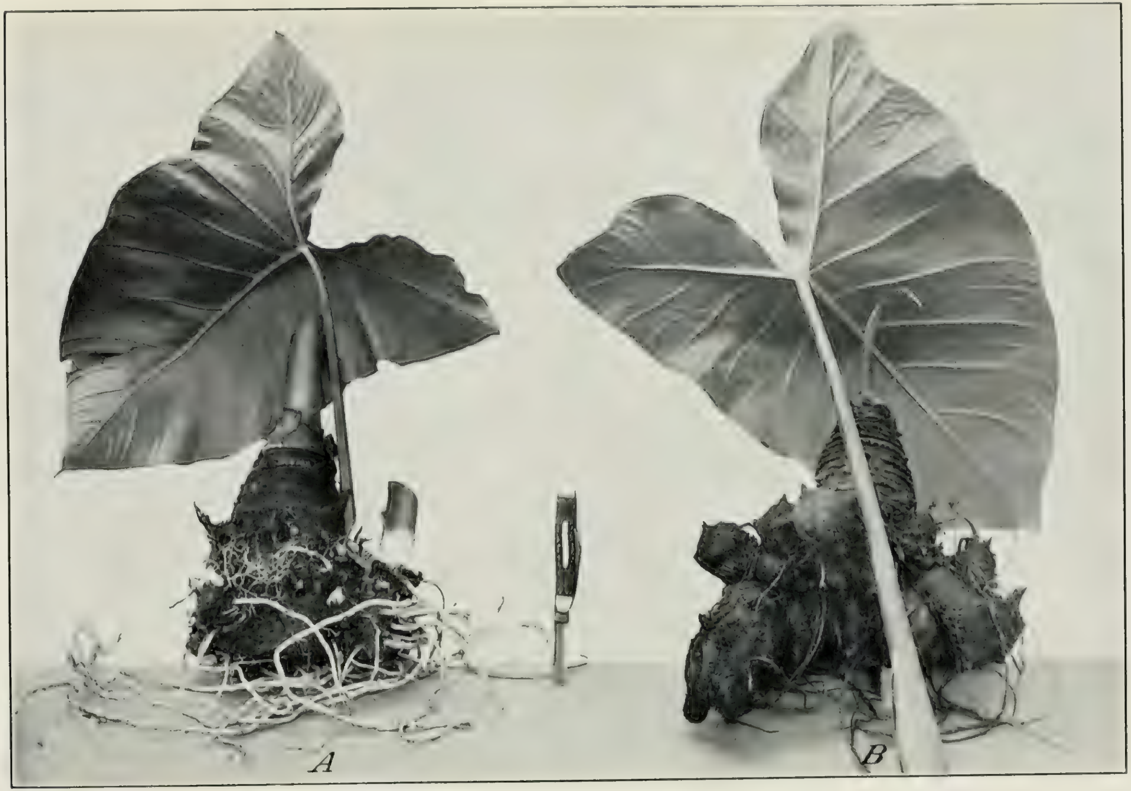
[a] Pronounced yow-tee′-ah.



LEAF AND ROOTSTOCK OF THE ALOCASIA AND OF THE YAUTIA.

A, Sagittate leaf, with leaf sinus nearly closed, and rootstock of the alocasia; *B*, sagittate leaf, with leaf sinus open, and rootstock, surrounded with tubers, of the yautia.

the petiole (see Pl. II, *B*). The shape of the blade is more or less triangular, with the retroceding basal lobes more or less rounded on the side toward the leafstalk. In the dasheens and taros, however, the blade is peltate, or shield-shaped, i. e., the petiole is attached to the under side of the blade, usually about half way between the center and the basal margin (see Pl. III); the tip may be rounded or prolonged into a sharp angle. A more or less pronounced marginal vein runs just inside the entire edge of the leaf, connecting the tips of the side veins and opening by large pores on to the margin itself; frequently in sunshine immediately after rain there is a superfluity of water in the plant, and this is reduced by the discharge of drops through these pores—a phenomenon known as "weeping," which is rather common among the aroids.

The entire plant of both the taro and the yautia is filled with laticiferous ducts containing a yellowish juice, which upon exposure rapidly thickens and turns brownish, forming a viscid gum. The true sap indelibly stains white cloth a reddish brown.

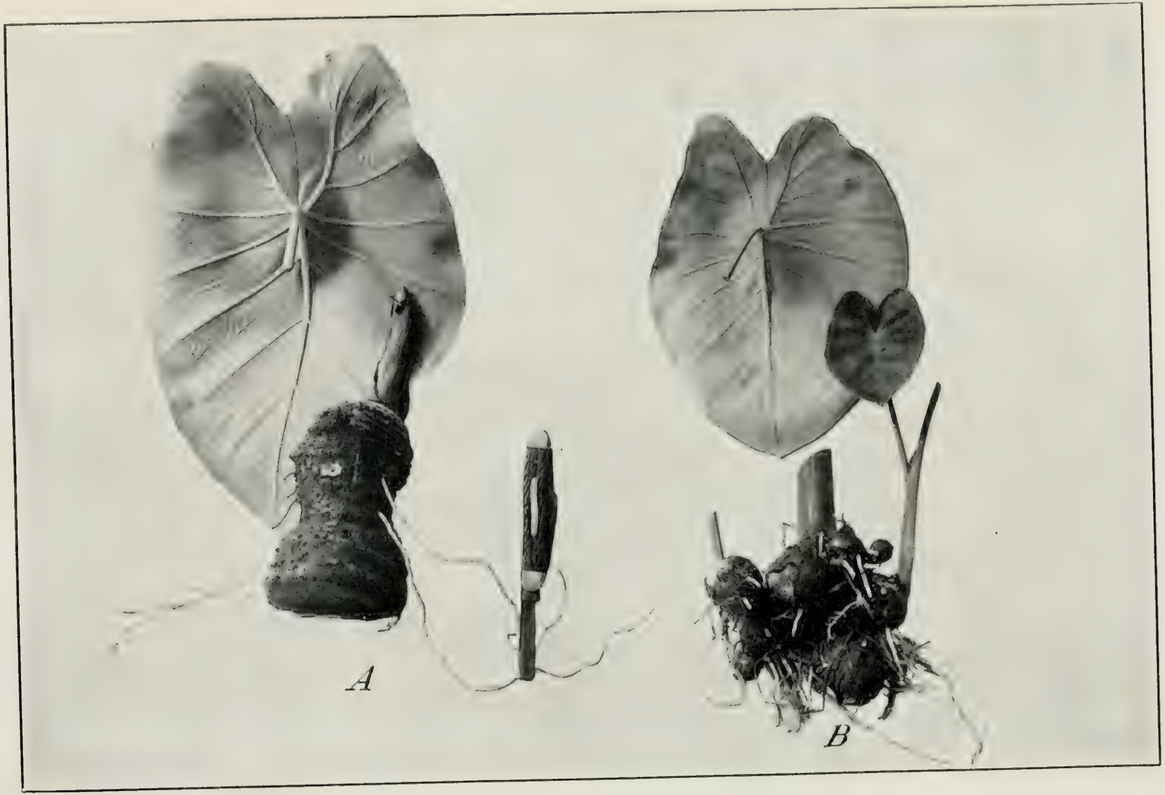
The tuber, which is morphologically merely a specialized horizontal branch of the more or less nearly vertical rhizome, varies in shape from a very slender root-like body, thickened toward the apex, to a nearly spherical form, the average shape, perhaps, being obovoid. The attachment may be weak, as in the case of the best types, the tubers of which may be readily snapped off from the central rootstock by a quick shake with the hand, or they may be strongly attached close about the parent root. The tubers are usually covered with a fibrous bark, especially near the apex. The color of the exterior is almost always, whether of the genus Xanthosoma, Colocasia, or Alocasia, a deep brown; the inner skin, however, may be white, rose, green, or purple, which shows particularly about the tip. The interior of the tuber is usually white or creamy white, but in some types it is yellow, orange, rose, or even purple. This feature is especially of interest when three or four sorts of as many colors are served together on the table.

Both the rhizome and the tuber bear more or less prominent buds, or "eyes," from which shoots may sprout under favorable conditions. The color, shape, number, etc., of these eyes upon the tuber vary constantly with the variety and are of considerable importance in distinguishing closely related forms. The rhizome is marked with distinct rings around its upper and thicker portion, which mark the axils of fallen leaf bases; just above these leaf scars are numerous small eyes, which seldom develop, whereas the lower portion of the rhizome bears another type of buds which may develop into tubers or, if exposed to light and air, into offsets and side shoots. The tuber also possesses eyes, or suppressed buds, which vary greatly in character, according to the variety of the plant. They are usually naked and irregularly situated.

The roots of the tuber are usually few compared with those of the rootstock. As in most aroids, the roots of the plants of these three genera are coarse, but rather long; they vary from white to red, are somewhat brittle, and contain comparatively little of the milky latex which fills most of the other organs of the plant. None of these plants are deep-rooted.

The flowers appear in palmate clusters from the axil of the leaf. The peduncles, which are about one-third of the length of the petioles, are more or less adherent or connate toward the base. Seldom more than one flower in a cluster is open at a time. At the moment of flowering, the peduncle stands erect; immediately upon the partial opening of the flowerets upon the spadix the peduncle withers and falls, though rarely the spathe and the spadix decay before the peduncle finally shrivels. As before stated, however, the flower buds seldom open and are usually discovered in a semidecayed condition in the axil of the leaf. The flowers of related species of plants are snail-pollinated; no snails, however, have been noted by the writer in the flowers of any species of either of these three genera. The few species of wild or semicultivated sorts which occasionally attempt to produce seeds are probably insect-pollinated. The odor from the spathe is usually pronounced and varies from an unpleasant pungent aroma to a nauseous perfume. The spathe inclosing the spadix, which bears the minute flowers, is usually green at the base and creamy white or yellowish red in its limb or upper portion, which may be erect or bent at right angles to the spadix. The pistillate or basal portion of the spadix is thicker and much shorter than the staminate extremity; the spadix in these genera is always straight. In the taros the extreme tip of the spadix is sterile. In the case of some of the yautias, the spathe may barely exceed the tip of the spadix, whereas in some of the taros it may be prolonged to about twice the length of the spadix; it may be open, like that of a caladium, in some of the yautias, or it may be strongly twisted into a cornucopia-like roll, as in some of the taros.

The name yautia is an Arawak word which was in common use in the Greater Antilles at the time of the arrival of the Spaniards. The meaning is probably "place of (ya') the hutia (or spiny rat, *Capromys* sp.)," which was formerly very abundant in tropical America and which fed upon roots and fruits. The origin of the name tanier is unknown. The "r" is usually not pronounced in the British West Indies, and the spellings "tannia" and "tania" are frequently seen. Eddo is probably an African word synonymous with taro, but frequently applied to the tanier. Coco is another term applied to the



LEAF AND ROOTSTOCK OF THE TARO AND OF THE DASHEEN.

A, Peltate leaf and tuberless rootstock of the taro; *B*, peltate leaf and rootstock, surrounded with tubers, of the dasheen.

yautia in the British West Indies. Malanga is the Arawak name for taro, and is still current in Cuba for both yautias and taros. In Panama the yautia is called by the Indian (San Blas?) name of otó, while in Mexico it passes under the names of quequeste, tekixcamote (probably a mongrel Indian and Spanish word), rejalgar, colomo, lampaza, and macal.

Since the yautias have been only very recently introduced into the Eastern Hemisphere, there are of course few native names in that region. However, the local names for the taro varieties are exceedingly numerous and complicated. Probably as many as 100 more or less distinct forms of the taro and of the closely related dasheen are now extant; many varieties have probably been lost on account of the radical changes in habits of the aborigines in the Pacific islands during the past few decades. The locality in which the cultivation of the taros began appears to be Polynesia, though this is not definitely settled. A number of varieties have been cultivated for many centuries, if not for thousands of years, in China and Japan. There is not much doubt, however, that all of the yautias originated in tropical America. The alocasias appear in South America, western Polynesia, the East Indies, the Malay Peninsula, and India. There appears to be no local name which is sufficiently common or distinctive to permit of its use in this work.

GENERAL CULTURE.

The planting of yautias, taros, and dasheens should be begun as soon as danger from frost is over, for they require six months or more to mature.

The plants may be set in rows for convenience of cultivation, though in the case of very wet lands, where horse tools can not be used and where the weeds are killed by allowing the water to stand at intervals, a close, haphazard method, as practiced in the Orient, is advisable.

The distance between plants depends largely upon the variety planted. Most varieties of yautias and taros require from 1 to 2 square yards of surface for their proper development; the dasheens, being of lesser growth, require only from one-half to three-fourths as much space. In rich alluvial soil, 5,000 to 10,000 plants may be set per acre. If planted in fairly dry soil, close planting in rows about 3 feet apart is recommended; this will allow cultivating the young plants with a horse hoe or cultivator.

Both the tops of the old rootstocks and the tubers themselves may be used as "seed." Even sections of the old rhizome of sufficient size for each chunk to bear two or more buds may be utilized. The "head," or top, of the rhizome, which is the preferred portion for planting, is prepared by cutting off the tip of the old stem, leaving ½ to 1½ inches of the leafless portion and about 4 inches of the basal portion of the rolled-up leafstalks. The dead bases of the petioles, if any, are peeled off from this head until fresh tissue showing the dormant buds is visible. In setting, the tip of the cylinder of petioles is left just above the surface of the soil; thus the portion of the rootstock is protected from overheating by the sun. Care should be taken, however, to allow no stagnant water to settle in the plant hole, as this would very likely cause rotting of the rhizome before the roots could be formed. In fact, sour soil containing stagnant water is of course injurious to any of these plants, especially when young. After growth has started, however, plenty of water moving through the soil is undoubtedly advantageous.

FERTILIZERS.

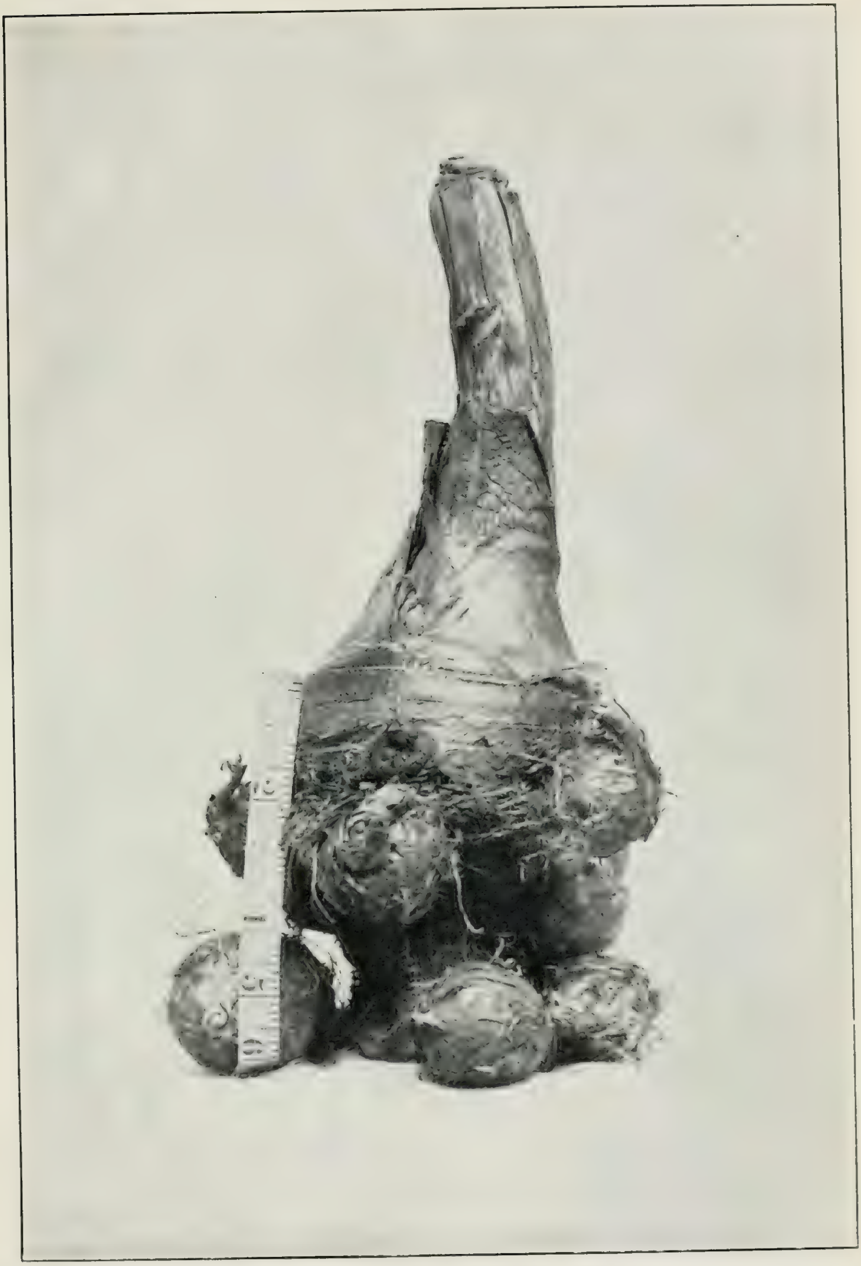
Like all root crops giving heavy yields, yautias, taros, and dasheens require either a naturally rich or a well-manured soil. Potash seems to be the element demanded. At the Porto Rico Experiment Station unfavorable results were obtained by the author with chemical nitrates and phosphates. Ordinary stable manure gave the best yield. Well-rotted coffee pulp on ordinary soil gave a yield of 12.4 tons per acre. Soil which can frequently be flooded will probably require no manure whatever.

HARVESTING.

The usual method of harvesting yautias, taros, and dasheens is by hand pulling, supplemented by the use of a pick or a mattock. The bundle of leafstalks of the mature plant is grasped in both hands, and if the soil is moist or sandy one strong pull usually brings up the entire root system; if some of the tubers break off from the rhizome and remain in the ground, they are readily brought out with a blow or two with a hoe. If the soil is packed, it may be necessary to loosen it, at least on one side of the hill, with a hoe before lifting the plant—after the manner of removing cassava roots.

The treatment of the tubers and rhizomes after removing from the soil depends upon the use to which they are to be put. Of course, as much earth should be removed as possible before hauling from the field; this can be accomplished in dry weather by simply leaving the roots in loose, shallow piles upon the soil surface.

In the West Indies "castration" of the tubers is sometimes employed; this consists in digging about the rootstock and removing mature tubers by means of a knife or even with the fingers. This process is of course not advised in this country, except where tubers are required for the table early in the season. Where the plants may



BASE OF A DASHEEN PLANT, SHOWING TUBERS.

be allowed to continue growth for eighteen to twenty-four months and where this method of castration is employed, it is undoubtedly possible to take as much as 30 tons of tubers from one acre in that time.

YIELD.

While single yautia plants may yield as high as 6 or more pounds of tubers to the hill, the average for common varieties in ordinary soil may be reckoned at 2 to 4 pounds per hill. The yield of the taro should be about the same as that of the yautia. The yield of the dasheen is 50 to 75 per cent of that of the yautia; however, in favorable conditions the yield may amount to 4 or 5 pounds per hill, which should give 15 or more tons of roots to the acre. The yield for alocasia varieties has never been calculated, but will probably be found to be somewhat lower than that of the yautias.

STORAGE.

If kept dry after being harvested, the roots resist decay fairly well; small packages of tubers can easily be kept six months in a dry atmosphere without losing much of their vitality. If left in the ground in situ they also keep fairly well and have been carried through the winter season in South Carolina, Florida, Alabama, and Texas. The roots, whether tubers or rhizomes, should be stored in such manner as to guard against frost, decay from dampness, and damage from animal pests.

DISEASES.

All parts of the plants, with the exception of the parenchyma of the leaf, are filled with a thick juice which appears to protect the plants against the attacks of insects, fungi, and bacteria under ordinary conditions. However, there are two or three forms of decay in the tuber which are due partly to fungous and bacterial infection and partly to physiological causes; these decays seldom affect any except tubers and rootstocks which have lain dormant in the soil or which were slightly infected with the germs at the time of harvesting.

During drought the margin of the leaf blade sometimes shows large, roundish patches of dead tissues.

A white mycelial growth is frequently found on the surface of tubers and rhizomes. On the former the white threads seem to do no injury whatever, but about the top of the rootstock there are frequently to be found patches of agglomerated hyphæ beneath which the cortical tissue is partially destroyed. The bases of the leaves are rarely attacked, but in a few cases have been noted as affected by a soft rot, probably caused by infection of this white mycelium. Heads or tubers showing any trace of the yellowish or whitish areas caused by fungous mycelium or any patches of soft-rot should be discarded in planting. The brownish fibro-vascular bundles frequently seen in tubers and rootstocks of material which has been kept for some time after maturing are to be looked upon with suspicion, though their presence is not necessarily a proof of the existence of a fungous disease.

COMPOSITION OF TUBERS.

The following passage is quoted from Bulletin 6 of the Porto Rico Agricultural Experiment Station[a]:

> Analyses of two samples of yautia have been made at the Maine Experiment Station, and the results given below are quoted from unpublished material. A white variety contained 85.9 per cent edible portion and 14.1 per cent refuse, i. e., parings. A yellow variety contained 76.9 per cent edible portion and 23.1 per cent refuse. In the preparation of ordinary Irish potatoes and sweet potatoes for the table, the edible portion constitutes on an average 80 per cent and the parings or refuse 20 per cent of the tuber. The following table shows the composition of the two varieties of yautia analyzed, calculated to a uniform basis of 70 per cent of moisture, and includes for purposes of comparison the composition of Irish potatoes and sweet potatoes:
>
> *Composition of yautias and potatoes.*

Yautia and potato.	Water.	Protein.	Fat.	Total carbohydrates.		Ash.	Fuel value per pound.
				Sugar, starch, etc.	Crude fiber.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
White yautia	70.0	1.7	0.2	26.3	0.6	1.2	529
Yellow yautia	70.0	2.5	.2	26.1	.6	.6	538
Irish potato	78.3	2.2	.1	18.0	.4	1.0	385
Sweet potato	69.0	1.8	.7	26.1	1.3	1.1	570

> The analyses show that yautias do not differ materially in composition from the potatoes. As is the case with potatoes, carbohydrates constitute the chief nutritive material. An examination of the yautias shows that the principal carbohydrate present is starch.

STARCH.

Yautia varieties range from about 20 per cent to 30 per cent of starch. Taro varieties are ill adapted to starch manufacture for two reasons: The starch grain is only about one-fifth the size of that of the yautia ($1\ \mu$ to $3\ \mu$,[b] see Pl. VI, figs. 1 and 4), which prevents the rapid settling of starch grains in water, and the rhizome of all taros examined thus far contains a gummy substance which renders the water in which the ground or grated root may be suspended of such a

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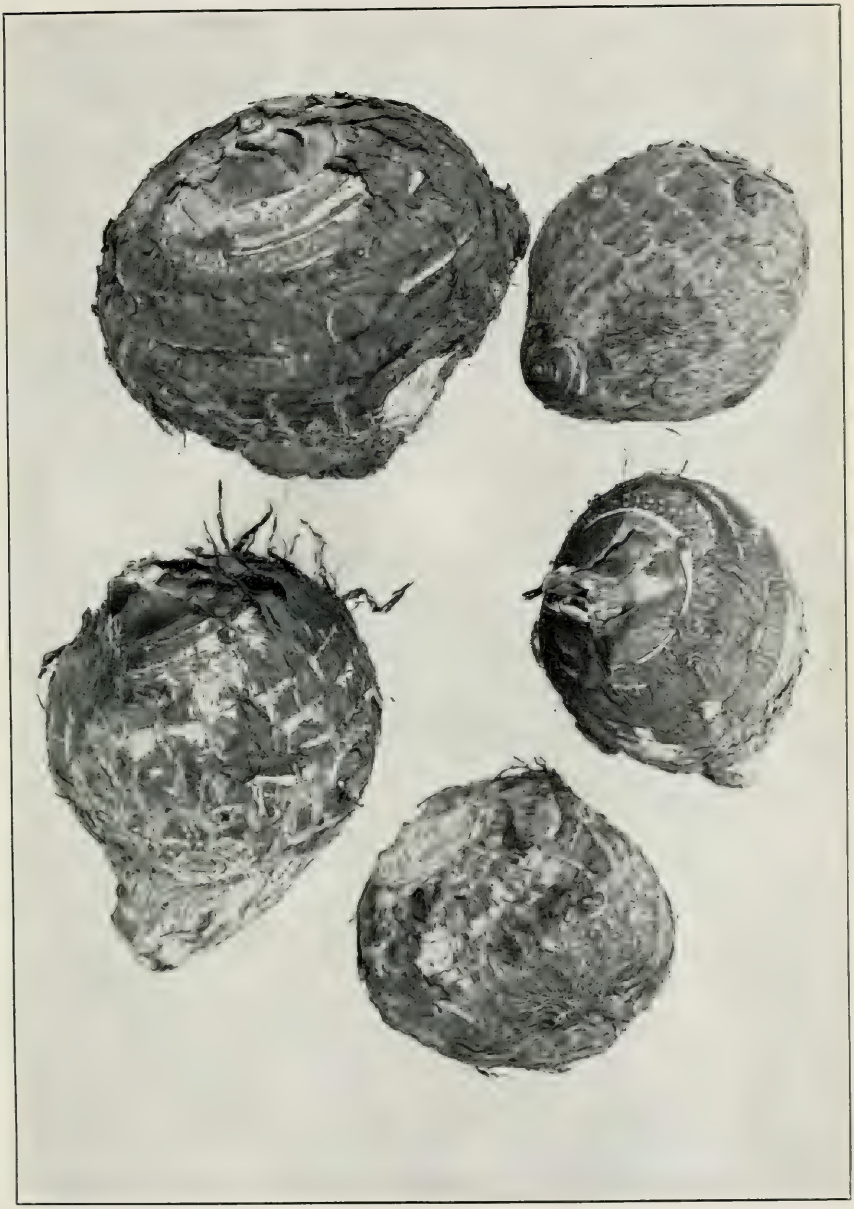
[a] Barrett, O. W. The Yautias, or Taniers, of Porto Rico. Bulletin 6, Porto Rico Agricultural Experiment Station, U. S. Dept. of Agriculture, 1905, p. 23.

[b] $1\ \mu = 1/1000$ millimeter, or about 1/25000 inch.



TUBERS OF A DASHEEN GROWN AT GOUGH, S. C.

(Seven-eighths natural size.)

viscous nature that the starch grains are prevented from sinking to the bottom. Alocasia starch (see Pl. VI, fig. 2) has been but slightly investigated thus far, but though the starch content of alocasia roots is somewhat less than that of yautias the gum contained is probably much less than in the case of the taro.

The size of the starch grain varies considerably in different yautias, and is probably affected to a greater or less degree by the soil conditions, seasons, etc., in which the starch was produced. The size of the starch grain in the dasheen and the taro does not seriously interfere with the use of these roots as alcohol producers or as a source for stock feed, flour, etc.

FLOUR, MEAL, ETC.

Flour made by grinding dry slices of peeled yautia tubers is considered in the West Indies more nutritious and fully as palatable as the famous cassava, or "bammy," cakes; it contains rather less fibrous matter and no trace of the rather dangerous hydrocyanic acid, which occurs even in the sweet cassavas under certain conditions.

Taro flour has been on the market for several years, and is said to form a very easily digested food for invalids, infants, and persons in whom the digestive function is weak. It may be mentioned that the principal food of the Hawaiian race was poi, made from taro roots, and in their language there was no expression whatever for indigestion. Flour made from the red or yellow tuber variety of yautias should prove an attractive article in the northern markets. About 70 per cent of the peeled tuber is water; thus 10 pounds of tubers, net weight, yield after 3 hours' drying about 3 pounds of flour. This flour will keep indefinitely without becoming musty if protected from moisture.

USES.

Yautia tubers boiled form a large part of the diet of the laboring classes in tropical America; in fact, the yautia ranks third in importance among the root crops in many countries of that region. The fried tubers enter into many dishes on the planters' tables. In some places, especially Jamaica, the larger tubers are baked and served like baked potatoes. The taro rootstocks may be eaten either boiled or baked, but are frequently served as purées and used in thickening soups and stews. None of the alocasias, with possibly a few exceptions, are suitable for table use.

In boiling, the thin skin should be previously removed. This skin may be left on in baking or roasting and may even be eaten along with the interior, as in the case of the true yams. When baked, the mealiness and peculiar flavor of the yautia are brought out much better than in any other method of cooking. The tubers of some yautia varieties are decidedly firm, even when thoroughly boiled; in fact, some of the varieties are best served mashed and made into small cakes, or croquettes, for otherwise—unless eaten at once while hot—the hard texture may be somewhat objectionable. The water in which the tubers are boiled should of course be well salted.

An excellent method of serving yautia tubers is as follows: Mash the thoroughly boiled tubers, then add milk or eggs and grated cheese; this mixture should be made into small, thin croquettes and fried. Parboiling, cutting in thin slices, and frying is a native method in tropical America which brings out the characteristic flavor to good advantage. In fact, the yautia may be used in any way in which the common potato is used, and while there is very little difference in flavor among the many varieties of potatoes there is considerable variation in flavor, as well as great difference in color, among the yautia varieties.

The young leaves of both taros and yautias cooked as a salad are a valuable addition to our list of pot herbs.[a] As compared with other greens, these leaves contain probably more nourishment, as well as flavor, because of the creamy sap contained in these plants, especially the yautias. The boiled leaves may be served either with a milk or cream sauce, or fried like cabbage or made into croquettes with eggs, cheese, and milk.

The Belembe yautia has a less rich but a more pronounced flavor, perhaps, than any other variety. The purple leaves of the Violacea type turn to a dull purplish color when boiled, resembling the purple-leaved cabbage. The petioles of some of the Japanese varieties are also cooked for greens, and in one case are said to be eaten raw. However, on account of the minute, needle-like crystals of calcium oxalate contained in the leaves, and to some extent in the outer portion of the tubers and rootstocks of both yautias and taros, cooking should always be carefully attended to. The alocasias contain a larger quantity of these crystals in the "blanket" portion of the roots than do either the taros or the yautias.

Few stock-feeding experiments have been carried out with either yautia or taro roots. At the Porto Rico Experiment Station yautias were fed to pigs with favorable results, except that when used as an unmixed ration it was believed there was a tendency to produce scouring.

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[a] Mr. H. F. Schultz, horticulturist in charge of the Commission's vegetable gardens of the Canal Zone, has grown thousands of pounds of "yautia spinach" for the officers' mess, and it has proved a great success as served on their tables, taking the place of spinach when the latter could not be supplied. Mr. Schultz states that he finds it difficult to supply the growing demand for this tender and spicy vegetable.

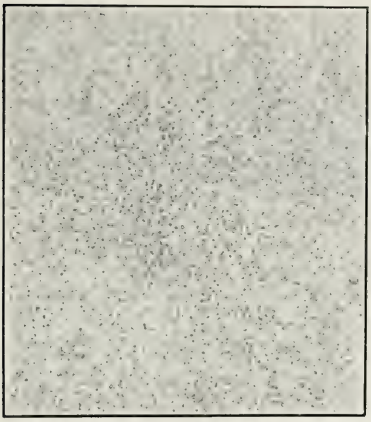


FIG. 1.—STARCH GRAINS OF THE TARO.

(Magnified 200 diameters.)

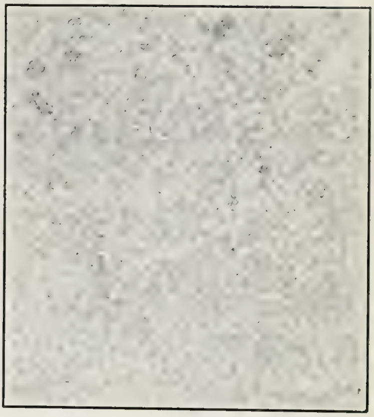


FIG. 2.—STARCH GRAINS OF THE ALOCASIA.

(Magnified 200 diameters.)

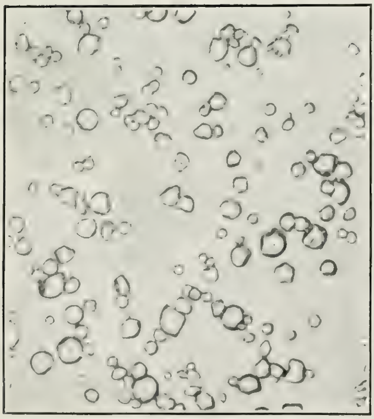


FIG. 3.—STARCH GRAINS OF THE YAUTIA.

(Magnified 200 diameters.)

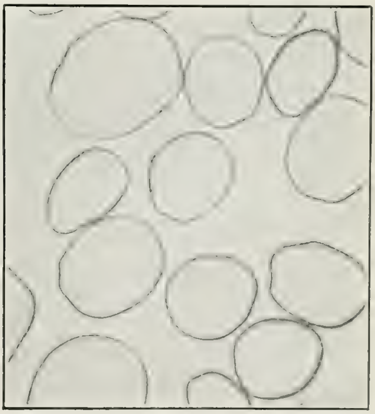


FIG. 4.—STARCH GRAINS OF THE CANNA EDULIS.

(Magnified 200 diameters.)

No experiments have been made thus far regarding the commercial methods of obtaining alcohol from these roots. It is believed, however, that many varieties will prove superior to potatoes in this respect, and the fact that yautias can be grown in the wet lands of the Southern States, where neither cassava, sweet potatoes, nor potatoes can be grown, renders the need for further investigation along this line decidedly urgent.

YAUTIA VARIETIES.

The known cultivated forms of this most interesting class of economic plants may be grouped under the following eight sections.

THE ROLLIZA GROUP.

The Rolliza variety (S. P. I. No. 14471) is in many ways the best form yet tested. There are many slight variations, or at least geographical forms, of this variety, which may be described as follows:

> Height 3 to 5 feet, with spreading petioles and triangular blades. The green petioles have a mauve line running along the more or less revolute sinus margin. The basal veins at the attachment of the petiole are always naked in mature leaves for one-half to 1 inch from the sinus. The tubers (Pl. VII) are comparatively large and regular in shape, i. e., nearly cylindrical, with the apex slightly larger and frequently somewhat bent upward; the eyes and roots are comparatively few; the interior is an even white throughout and the flavor when cooked is excellent. Flowers are almost never produced in this variety. Time for maturing, eight to eleven months, depending upon dryness of season and soil. Adapts itself more readily to various conditions than most other varieties.

This is the most widely distributed type of yautia, and is known to occur in Venezuela, Trinidad, Dominica, Porto Rico, Isle of Pines, Cuba, Santo Domingo, Mexico, British Honduras, and Surinam. Closely related varieties have been received from Ceylon (probably introduced from South America), British Guiana, and Colombia. The many forms of this variety differ in the amount of color in evidence upon the outer portion of the petiole, in the width and shade of the sinus margin stripe, in the vigor of the plant, etc. It is probable that extensive field tests of these forms would show that several, at least, have tubers with characters which make them readily interdistinguishable.

A Jamaica variety (S. P. I. No. 15397) very similar in appearance as to leaf and leafstalk, and even the root system, produces tubers having a tendency to come to the surface of the soil and with a distinct taro-like flavor when cooked; according to Mr. Nehrling they are sometimes found standing erect above the soil surface about the mother plant.

A variety which has been in the trade as *Alocasia marshalli* (S. P. I. No. 15401) is of unknown habitat, and though the tubers are scarcely distinguishable from those of the Rolliza the entire petiole is covered with a glaucous, bluish bloom and stands more erect than in the type variety.

A variety from Jamaica (S. P. I. No. 15415) has a leafstalk reddish toward the base and with a wider maroon stripe on the sinus wing, while the midrib and the basal veins of the blade are reddish beneath.

Two other Jamaica varieties (S. P. I. Nos. 15406 and 15418) closely resemble the parent type, but the tubers of the former are smaller and more numerous, while the petiole of the latter is of a brighter green and has a more strongly colored sinus stripe.

A variety known in Porto Rico as the "Blanca" (S. P. I. No. 15419) has erect petioles and more slender rhizomes, which curiously enough contain numerous raphidian crystals which bar the rootstocks of this variety from the table, although the tubers are apparently free from this defect; this variety is supposed to endure more stagnant water in the soil than its sister sort, the Rolliza.

A variety from Honduras, via Florida (S. P. I. No. 17462), may belong to another type because of its yellowish tubers and the extra amount of color on the sinus wing and the base of the petiole.

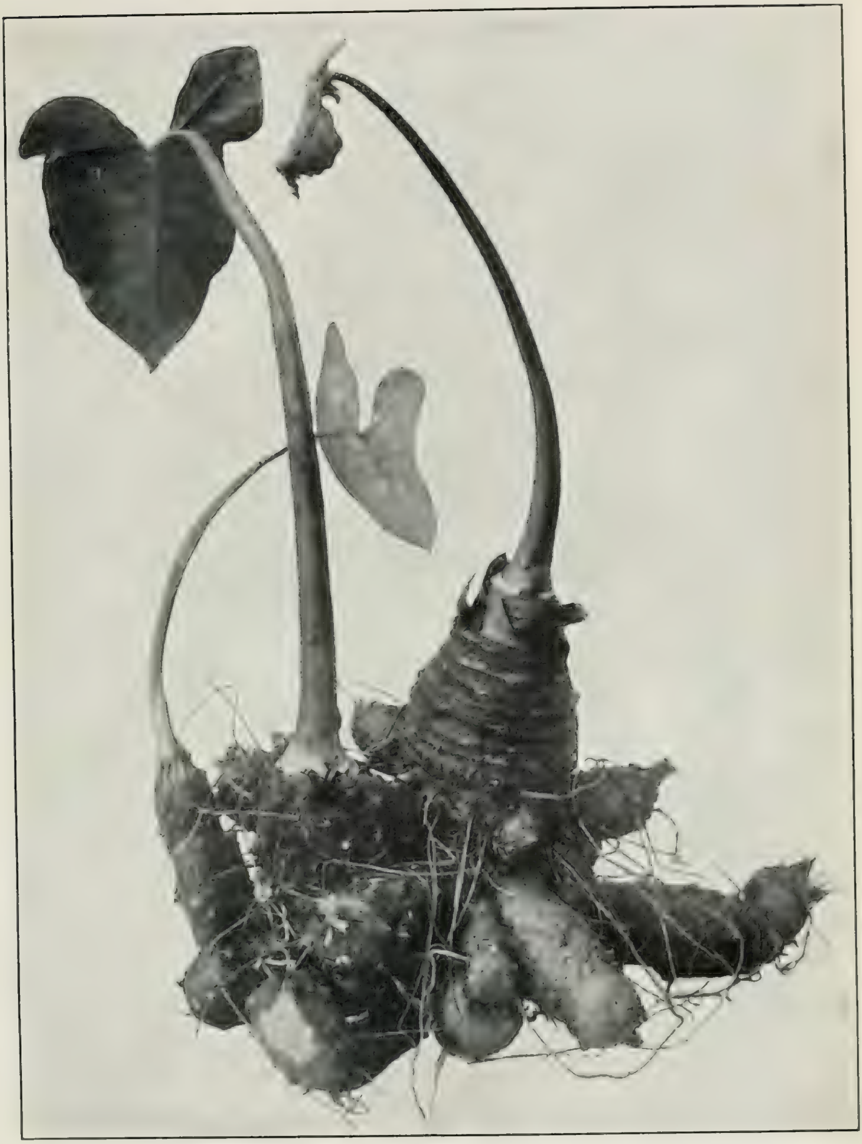
A variety received from Singapore (S. P. I. No. 18384) also has a creamy white tuber and a leaf blade somewhat more shining than in the Rolliza. The origin of this variety is undoubtedly tropical America; this was received as *Alocasia indica*. A variety (S. P. I. No. 19271) cultivated in Texas as an ornamental proves to be quite distinct from Rolliza on account of the exceedingly slender tubers.

A variety which has been in the trade as *Alocasia javanica* (S. P. I. No. 19291) may perhaps belong to a distinct type; the tubers are numerous, clustered, of irregular shape, and white inside with greenish inner rind; there are also slight peculiarities in petiole and blade.

A variety (S. P. I. No. 20484) from Santo Domingo also has creamy white tubers. A variety in northeastern Mexico, the Lampaza (S. P. I. No. 17149), is entirely green with the exception of a narrow line on the sinus margin; another variety there, the Rejalgar (S. P. I. No. 20970), has a petiole reddish at the base and bluish in the middle, while the blade has a violet margin, and in the young leaf the veins are shaded red beneath; the natives do not cultivate this latter variety, but gather the young leaves and petioles for greens and to mix with their stews, while the tubers are also mashed and made into a gruel, according to Dr. Edward Palmer.

THE MANOLA GROUP.

The plants in the Manola section are characterized by the flatness of their leaf blades—in this resembling many of the alocasias, but the naked basal veins at the sinus make them xanthosomas. The varieties belonging to this type are usually of more dwarf size than



ONE OF THE BEST TABLE VARIETIES OF YAUTIA, THE ROLLIZA, SHOWING NUMEROUS TUBERS ATTACHED TO THE ROOTSTOCK.

those of the Rolliza section, and the tubers are variable. The plants are adapted to much drier soils and they withstand long periods of drought much better. This type appears confined to the island of Porto Rico.

The Manola yautia of Porto Rico (S. P. I. No. 15405) may readily be distinguished by its very flat, broadly triangular leaf blade and its comparatively short petioles, which are scarcely colored at all on the margin of the sinus wing. The color of the tubers varies inside according to their size and maturity from pale yellow to orange; the exterior is rough, with numerous small eyes.

The Gengibrilla yautia of Porto Rico (S. P. I. No. 15388) has a much more slender petiole, with less bluish glaucous coloring on the surface, but with considerable reddish maroon shading on the inside of the sinus wings. On account of the very slender tubers it is doubtful whether this variety can correctly be placed in this group, notwithstanding the flatness of the leaf blade.

A very rare variety discovered in the west end of Porto Rico and known there as the "Islena" (S. P. I. No. 15390) may be distinguished from the Manola by the large irregular blotches of reddish purple and maroon on the outside of the sinus wing. The tubers are normal in shape, but pinkish inside and of high quality.

THE AMARILLA GROUP.

Varieties in the Amarilla group are the most dwarf of all yautias, and though closely resembling the Rolliza varieties as to blade and petiole the very short and rough tubers which are of a yellowish or orange color inside distinguish them from those in the Rolliza section, while the concave or irregularly curved blade separates them from yautias of the Manola type. Varieties of the Amarilla type are known to occur in Cuba, Santo Domingo, Porto Rico, and Dominica, and they probably occur in some of the South American countries.

The Amarilla of Porto Rico and Cuba (S. P. I. No. 15387) has short petioles covered with a glaucous gray bloom, but without any purplish shading on the sinus margin. The tubers are short, small, very firm, yellow inside, and of very rich flavor; their keeping qualities are excellent when not affected with fungous diseases previous to harvesting. During the dry season the tubers may be left in the ground for weeks, or even months, and removed from time to time as required. While the yield is not so high as in some other types, the richness of the flavor and the good keeping qualities render it a popular variety.

A larger variety of the Amarilla type, the "Dominica," or "Samanal," of Porto Rico (S. P. I. No. 15408), is distinguished by having a few blotches or stripes of a maroon color along the sinus margin, by its much more slender habit, and by the paler color of the leaf blade.

The tuber in some respects is the finest flavored and richest of all the varieties of yautias tested thus far. It should be generally cultivated, since it proves fairly productive and resistant to fungous attacks.

THE MARTINICA GROUP.

Most varieties of the Martinica section are strong growing, handsomely colored, and fairly productive. The petiole is usually striped, especially near the sinus. The leaf blade is usually dark in color; the tubers are of fair size, but short, rough, and beset with numerous small eyes; the interior is yellow or orange. The type of this section, the Martinica (S. P. I. No. 15385, probably introduced from Martinique), is sometimes known as the "Huevo," on account of the egg-shaped tubers; as the "Quintal," from its supposed maximum yield of 100 pounds per clump; and as the "Amarilla," from the bright-yellow color of the tubers. This plant, which has been known in the trade as *Xanthosoma maculatum*, is one of the most striking varieties when well grown; the petiole sometimes attains a height of 4 or 5 feet and is beautifully shaded with cream and rose on a green background, while along the sinus wings are irregular blotches of maroon and reddish brown. It is fairly productive, but there is a tendency to overstooling, and for this reason it should be harvested as soon as the tubers are mature; if left in the ground like the Amarilla these tubers usually send up new shoots even during the driest weather. The tubers are perhaps more nearly cylindrical than in any other variety; however, they bear many roots and are firmly attached to the central rootstock. The color is deep yellow inside, and when cooked this turns to a deep olive or grayish yellow shade. The tubers are so rich that only a few ounces suffice for the carbohydrate portion of a meal. Like the tubers of the Amarilla, their firmness is a rather objectionable characteristic. Not only does this variety flower more frequently than any other, but teratological monstrosities have been noted in several instances, as, for example, double spathes, coherent peduncles, and distally flattened spadices. Unfortunately this otherwise highly desirable variety appears susceptible to fungous diseases and does not endure drought well.

The Orqueta (S. P. I. No. 15379) is an exceedingly rare variety which is confined to a small district of Porto Rico. The leafstalks are the palest of all the yautias, in some cases when grown in the shade being nearly white; there are always, however, a few faint streaks of maroon along the sinus margin. The leaf blade is also of a pale yellowish green color. The tuber is yellow or orange inside. This variety is inferior in point of hardiness and productiveness, but is of some use as an ornamental, and in moist, rich soils will yield a fair crop.

THE OTÓ GROUP.

Varieties of the Otó section have a general resemblance above ground, but the tubers are exceedingly variable in color. The petioles are always strongly colored, either reddish, bluish purple, or glaucous maroon; the whitish bloom common to most yautias is more in evidence in this than in the other sections already mentioned. The plants are usually of medium to large size, and though results of field experiments are lacking, there is no doubt that some of the varieties will prove of high value.

The so-called "Jamaica tanier" of Trinidad (S. P. I. No. 15383) has reddish brown petioles with a glaucous sinus wing, which becomes deep reddish purple along the margin, which is usually rolled inward. The midrib and basal veins are mauve-purple beneath, especially in young leaves. The rhizome is orange-yellow inside and the tubers are of a decided yellow shade.

A variety received from the Jamaica Department of Agriculture (S. P. I. No. 15403) resembles the one just mentioned as to blade and petiole characters, except that there is more of a reddish or scarlet tinge at the base of the leafstalks and along the sinus margin. However, the tubers are of a pronounced rose color and comparatively short, while the rhizome is of a pale-rose tinge throughout.

A variety received from Guatemala (S. P. I. No. 15804) is probably identical with the Jamaica of Trinidad, but appears to be more vigorous and prolific. A similar variety (S. P. I. No. 16947) from Kamerun, West Africa, differs from the two previous sorts in having white tubers. This variety was probably introduced from tropical America.

The Otó of Panama (S. P. I. No. 19715) has a reddish, very erect petiole with strongly reflexed sinus wings, marked with numerous purple lines; the blade is short, but the basal veins are less exposed than in most varieties. The tubers are of a beautiful rose shade.

A variety from Santo Domingo (S. P. I. No. 20488), similar to the preceding, has a pronounced bluish glaucous bloom on the leafstalks, and the pale flesh of the rhizome is marked with dark-purple lines along the fibro-vascular bundles.

THE VINO GROUP.

The varieties of the Vino section of yautias are usually dwarf or medium in size, with more or less coloring of the leafstalks and with pinkish or purplish tubers. The tendency to "sucker" is an objectionable feature. These yautias should be grown upon rich, moist soils and planted comparatively close. The flavor of the tubers, together with their unusual color, which is even more pronounced after cooking, renders them of high value for the table.

The Vino, or Punzera (S. P. I. No. 15377), of Porto Rico is apparently confined to the West Indies and is nowhere common. The leaf blade is of a dark-green shade with light-colored veins, and the petiole is stained purple along the inside. The tuber is distinctly flaky or "mealy" when baked, or even when boiled, and has a delicate nutlike flavor distinct from that of most other yautias. No record of the flowering of this variety has been obtained.

The Islena of the south side of Porto Rico (S. P. I. No. 15410) is the largest variety of this section and sometimes attains a height of 6 feet. This variety in blade, petiole, and tuber is very similar to the Vino.

Similar varieties have been received from Grenada and Santo Domingo; one from Haiti (S. P. I. No. 17703) has a dark-violet margin around the blade and the young leaf is stained maroon, except along the veins, while the sinus margin is irregularly marked. The rose-tuber form (S. P. I. No. 19778), called the "Tekixcamote," of Chiapas, Mexico; the red-tuber form (S. P. I. No. 20864), called the "Macal," of Tabasco, Mexico; and a variety having strongly colored petioles (S. P. I. No. 17463; see Pl. VIII, fig. 2), from Honduras, belong in this section, but have not been sufficiently studied.

THE SENTEH GROUP.

The three varieties of the Senteh type have been received only from Java; theoretically, all of the East India xanthosomas were introduced from tropical America, but it is believed that the American prototypes have in this case become extinct in the Western Hemisphere.

The Senteh (S. P. I. No. 17236), which was received as *Alocasia macrorhiza*, may readily be distinguished from all but one of the other yautias by the strongly contrasted dark-maroon or bronze-purple blotches along the sinus wing and on the sides, and even the back, of the petiole, especially toward the base. Although the young petiole is sometimes nearly white, in a few cases it has been noted of a blackish purple color. The leaf blade resembles that of the Rolliza, but is somewhat shorter. The tuber also resembles that of the Rolliza type.

The "talus soerat" (S. P. I. No. 17239), which was received from the Botanic Gardens at Buitenzorg as *Colocasia monorhiza scripta*, closely resembles the Senteh; however, the striping of the petiole is much less in evidence and the tuber is of a yellowish white color inside and, besides, has a tendency to rise above the soil surface. Both this and the previous variety should be cultivated as ornamentals either in beds or indoors in pots. The yield and quality of the tubers have not been determined.

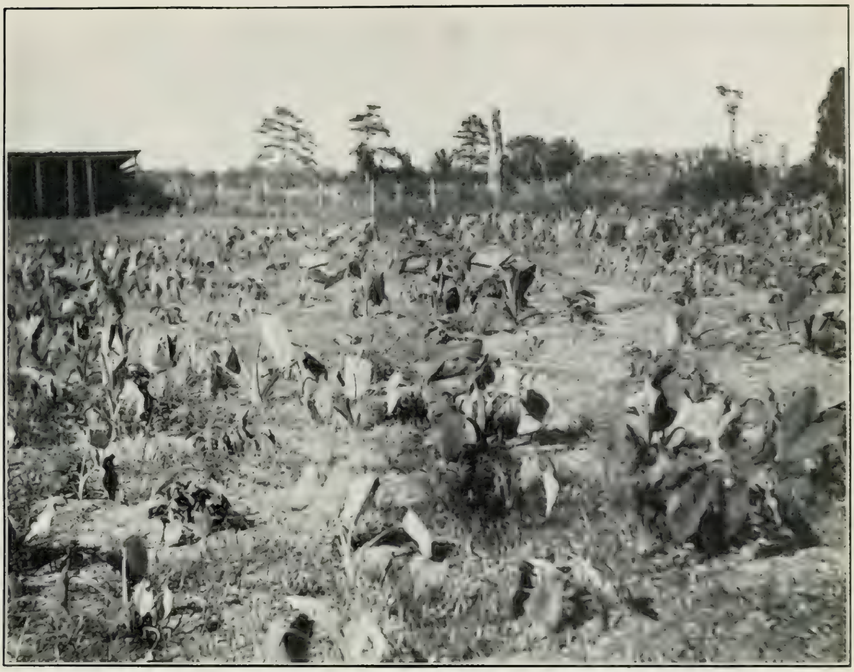


FIG. 1.—YAUTIAS AND TAROS GROWING AT CAT ISLAND, S. C., SHOWING YOUNG PLANTS IN AN UNFAVORABLE SITUATION.

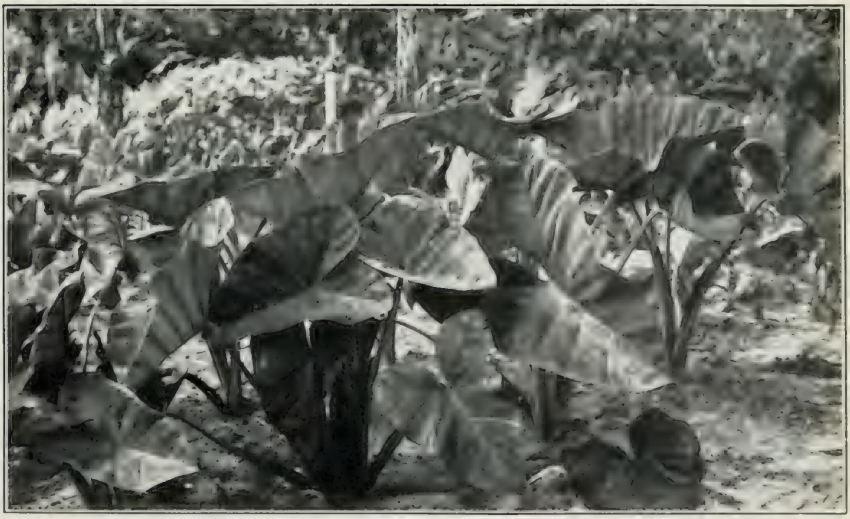


FIG. 2.—YAUTIAS (S. P. I. NO. 17463) FROM HONDURAS GROWING AT GOTHA, FLA., UNDER FAVORABLE CONDITIONS.

S. P. I. No. 20948 resembles the typical Sentch, but has more purplish shading on the lower portion of the petiole. This is one of the most striking varieties of yautia for ornamental purposes.

THE VIOLACEA GROUP.

The two varieties of the Violacea type are very distinct from all other yautias. The entire petiole, with the exception of the extreme distal portion, is of a dark blackish purple, suffused with a glaucous bloom; the leaf blade is normal as to shape, but the color is very dark, while the midrib and larger veins, especially in young leaves, are of a pronounced purplish tinge.

The Guayamera (S. P. I. No. 15394) has been in the trade as *Xanthosoma violacea*. This form was received from the Buitenzorg (Java) Botanic Gardens as *Colocasia antiquorum niger*, and from the Singapore Botanic Gardens as *Alocasia violaceum*. The leaf blade is bent at an acute angle, or at most at a right angle, with the petiole, which stands erect and attains a height of 5 feet. The tubers are rather slender, of medium size, and of a pronounced pinkish or rose color inside. Flowers are almost never seen. Although a very popular variety in Porto Rico, the author never found tubers for sale in the market.

The Prieta, or Morada (S. P. I. No. 15404), is an exceedingly rare variety apparently confined to Porto Rico. It is distinguished from the preceding variety by its leaf blades being at a normal angle instead of nearly vertical, and by its orange instead of rose tubers. This variety, which is of first quality for table use, should be planted in rich, moist soil. It appears to be subject to root troubles if exposed to prolonged drought.

THE PALMA YAUTIA.

It is probable that the Palma yautia (S. P. I. No. 15414) will prove to be botanically distinct from the *Xanthosoma sagittifolium* varieties. The leaf blade, which sometimes measures 4 feet long by 3 feet wide, is strongly concave, like that of most true yautias, but the basal veins of the laminar sinus are much less exposed. The rhizome is caulescent, sometimes rising to a height of 3 or 4 feet above the soil surface. The very small tubers are produced only under very favorable circumstances. However, the large rhizome, which may in one season attain a diameter of 4 or even 6 inches, is used as poultry and pig feed by the natives; for this purpose it should be cut in chunks and boiled. The yellowish or orange interior of the rootstock contains about the same percentage of starch as the Rolliza variety, although the fibro-vascular bundles are more in evidence. Ten pounds is af air weight for a 1-year-old rhizome. This variety frequently flowers, and the spathe (see Pl. IX, fig. 2) is 12 to 18 inches long, rather slender, glaucous maroon below, shading to a pinkish yellow above. The odor is rather unpleasant and pungent. The petiole is shaded from purplish maroon along the sinus to dull-green distad.

THE BELEMBE YAUTIA.

The Belembe (*Xanthosoma hastifolium*), a dwarf species of yautia (S. P. I. No. 15412), is cultivated in Porto Rico and Panama for its leaves, which have an aromatic flavor when boiled. It seldom attains more than 2 feet in height and prefers half shade in moist soil. The petiole is erect, dark green, with a long blade having large, slightly twisted basal lobes. The corm may become multiple-headed from the sprouting of numerous offsets, but no true tubers are ever produced. Only the leaves are utilized. Flowers are sometimes seen.

ALOCASIA VARIETIES.

The Alocasia group contains little-known plants whose taxonomic relationships have not yet been worked out. In fact, since they very seldom flower, it is almost impossible to accurately determine their specific names. On account of the insoluble crystals of calcium oxalate (raphides) contained in the cortical portion, or "blanket," of the rhizome, it is not safe to use any of the alocasias as table roots or for poultry or stock feeding, although for the latter purpose they can probably be utilized when thoroughly boiled. These plants are of especial utility where a quick-growing root containing a medium quantity of starch is required. In the Tropics, where growth is practically continuous in the moist soils along rivers and mountain streams, 10 to 25 pounds may be calculated as the normal weight for a rootstock of from 1 to 2 years of age. Many of the South American forms which may prove to belong to a closely related genus have the objectionable habit of overstooling.

Among the collection received from Surinam a few forms, like the Abo (S. P. I. No. 19222) and the Koso (S. P. I. No. 19221), have considerable color on the petiole, which frequently shades into a purplish zone about the tip of the rhizome. The leaf blade somewhat resembles that of the Palma yautia, but is more flat, with less prominent veins and a more nearly closed laminar sinus (see Pl. II, *A*). The color of the interior of the rhizome varies from white to orange.

ALOCASIA MACRORHIZA.

The *Alocasia macrorhiza* is seldom cultivated in Porto Rico, where it bears the common name of Panama, but is frequently used for feeding pigs. The plant is an even, dark, shining green throughout,

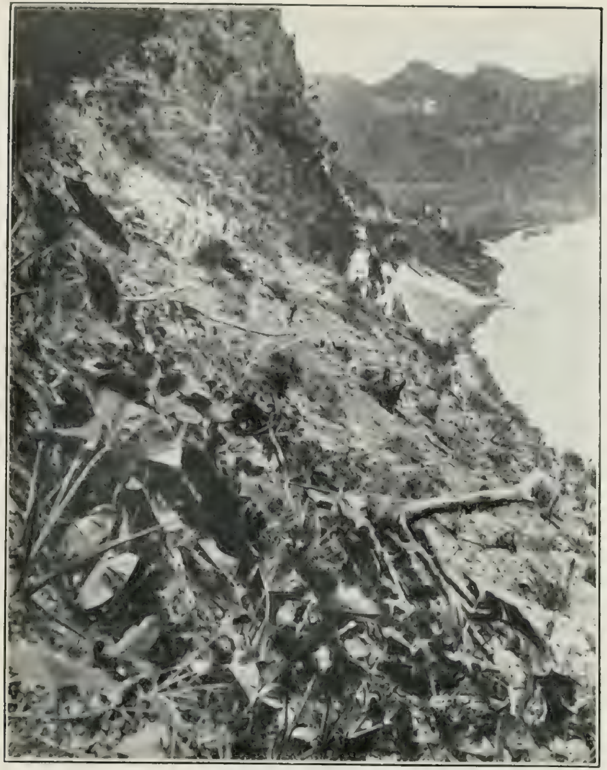


FIG. 1.—YAUTIAS GROWING ON A STEEP HILLSIDE NEAR THE ROAD BETWEEN UTUADO AND ARECIBO, PORTO RICO.

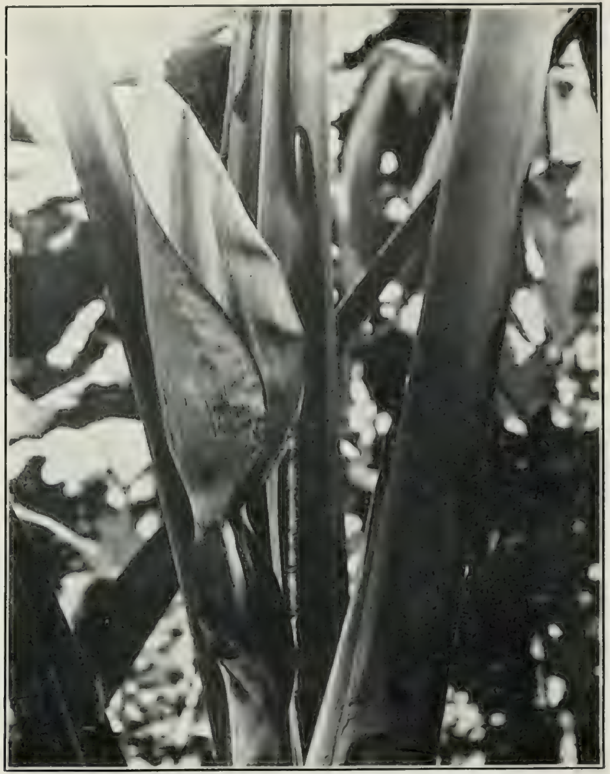


FIG. 2.—FLOWER OF THE PALMA YAUTIA.

though the inside of the rootstock is white. The laminar sinus is practically open, though the basal veins are always covered. Even 9-foot plants have thus far resisted all attempts to shock them into flowering. It is believed that this variety will succeed better as a starch root than even *Alocasia indica* or *A. odora*, though prolonged field tests are necessary to determine this point.

TARO VARIETIES.

Though among the oldest cultivated plants in the world, the fifty to one hundred varieties of taro now in cultivation have received very little scientific attention, and are consequently in a deplorable state of taxonomic confusion. Undoubtedly the larger number of these forms will be found to conform to the limitations of the species *Colocasia antiquorum* and to its principal variety, *C. antiquorum esculentum*. For convenience in cultural discussions we may divide the genus into two groups, viz, the true taros and the dasheens. The petioles and blades of both groups are very similar (see Pl. III). However, the tuberous offsets of the dasheens are seldom found among the true taros, although thickened, stolon-like, and more or less superficial offsets are common under certain circumstances in some of the taro types. The leaf is always peltate, though the angle which the blade forms with the petiole is variable; the comparative width of the blade and its irregular marblings and mottled areas are also inconstant. Among the dasheens a bronze-purplish shading of petiole is a permanent feature, which, taken with its dwarf size and the tubers, renders the two groups readily separable. Among the taros color and markings run rampant; indeed, even the sap of two or three varieties is colored, or at least colors instantly upon exposure to the air.

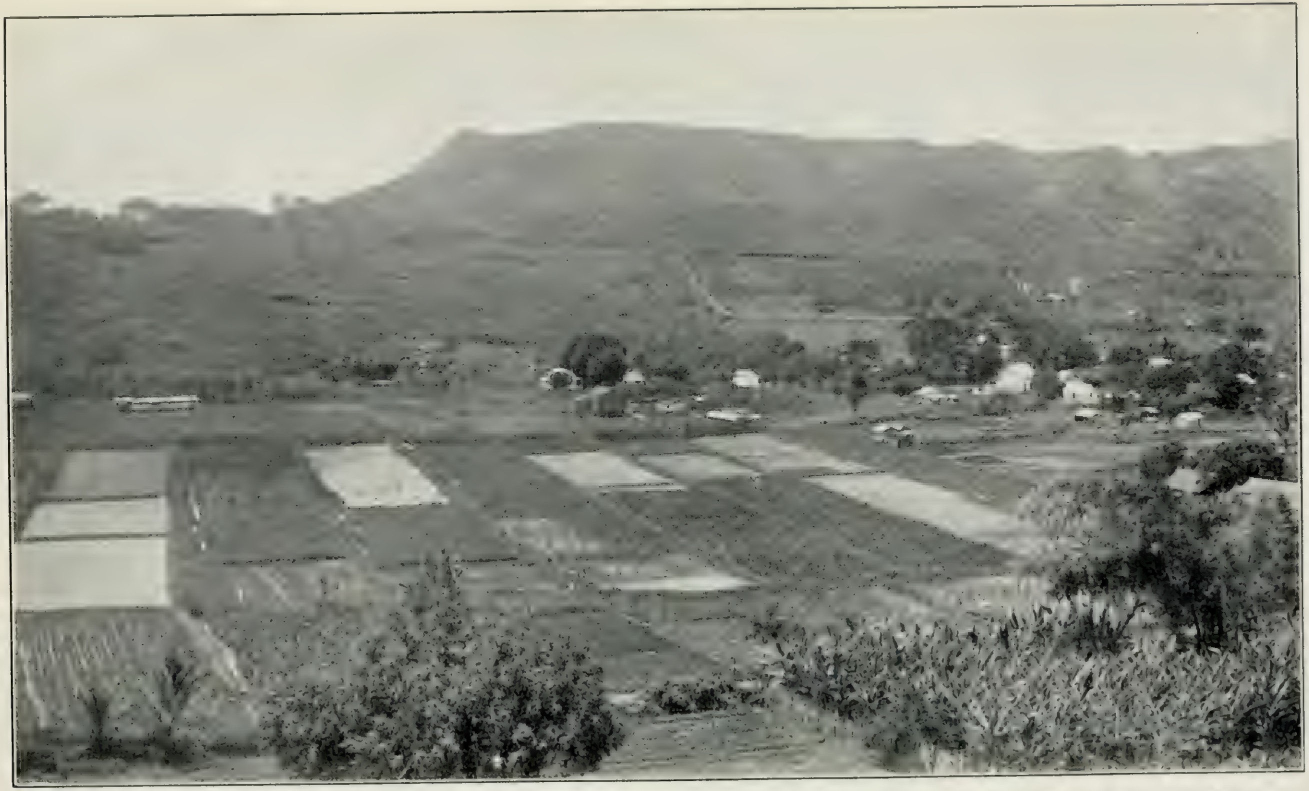
In Hawaii, where forty-five distinct varieties are recognized, the taros are roughly divided into upland and lowland sorts. Varieties of the latter type are usually flooded at frequent intervals during the growing season (see Pl. X), partly to keep down weeds and partly because the plants require a great quantity of water. Although most taros contain from 15 to 25 per cent of starch, the size of the starch grain itself (see Pl. VI, fig. 1) is so small (1 μ to 3 μ) and the gum content of the root is so high that it is doubtful whether any commercial method for extracting the starch from either the taro or the dasheen can readily be found. However, for grinding into flour or meal or for alcoholic distillation roots of both types of this section are eminently adapted. Two or three companies have already placed upon the market a flour made by grinding the cooked roots of some of the Hawaiian taros.

Perhaps the commonest, or at least the most widely distributed, of all the taros is the common West Indian "eddo," or, as it is known in Porto Rico and Cuba, the "malanga." This variety attains a height of 3 to 5 feet, has comparatively few suckers, and produces in six to ten months a more or less cylindrical or fusiform rhizome from 6 to 12 inches long by 3 to 4 inches in diameter. The leafstalks are pale green, becoming almost white toward the base, although at the point of attachment with the rhizome there is frequently a distinct shade of rose. The leaf blade is bent at a considerable angle with the petiole, so that in the mature leaf it hangs nearly vertical. The rootstock is more or less covered with a fibrous bark similar to that of the yautia root; it has practically no blanket of poisonous tissue about the starchy interior. Not only is there a slight trace of tannin in the mucilaginous juice of the root—which of course becomes black when touched with iron or steel—but it appears to have some ferment which upon cooking changes the juices of the root to a purplish black shade. Hence the boiled taro root has not the inviting white appearance of the yautia tuber upon the table. The fibro-vascular bundles of the rhizome are small as compared with those of the yautia rootstock. The fungous diseases which attack the yautia are also in evidence among the taro and dasheen varieties, although the latter root appears to be much more resistant than the former.

It appears that there are several forms of this typical West Indian taro, which vary in point of color of the petiole base and of the top of the rhizome. The strongest variation from this type, which should perhaps stand in a class by itself, is the highly colored Royal or Lehua taro (S. P. I. No. 19952) of Hawaii. This variety, which was formerly cultivated solely for the royal families, contains a blood-like sap and produces purplish or rose-colored roots; even the veins in the leaf blade are more or less tinged with reddish purple. This is an upland variety requiring comparatively little water, which should be generally cultivated as a first-class table tuber for the fancy-vegetable market.

STRIPED TAROS.

The marblings or stripings of the petiole and the more or less pronounced marbling of the leaf blade in this section of true taros serve to readily distinguish the forms superficially. The shape of the blade varies from the exceedingly narrow and flat form found in a variety from Sibpur, India (S. P. I. No. 17102), to the strikingly striped varieties from Java, like the "talus belang" (S. P. I. No. 20954), which has pale-green petioles entirely covered with more or less irregular bands of bronze-green, while the blade itself is strongly marbled in light and dark green patches. The "talus koekoek" (S. P. I. No. 20953), also of Java, has petioles nearly white, with a slight brownish narrow striping, especially on the young leaf, while



TAROS UNDER CULTIVATION IN WET GROUND NEAR HONOLULU, HAWAII. IN THE LIGHTER AREAS THE PLANTS HAVE NOT YET COVERED THE STANDING WATER.

the sinus wings are involute and the blade a bluish green shade with a weak, slightly crumpled margin. The "kempol koenig" (S. P. I. No. 20945), of Java, has the palish petiole covered over with minute, cross-hatched, darker green lines.

The petiolar spot on the upper surface of the blade varies from a yellowish green to a pronounced purplish shade, which may be en masse or in the form of radiating lines. The color of the roots varies from ivory-white to orange-yellow. In some varieties there is a tendency to produce many offsets.

RED TAROS.

Only ten or twelve distinct sorts of red taros are included in the collection made by the writer, though it is probable that this number could be easily doubled, or perhaps trebled. However, the red or black taros are comparatively rare and until last year were practically unknown in the Western Hemisphere. The colors of the petiole vary from a pale reddish or maroon tinge to an almost black color. Of the latter type, the "kalukandala" (S. P. I. No. 17461) of Ceylon may be taken as a type. This strong-growing and highly ornamental variety holds its nearly erect black petioles 4 to 6 feet high. The rhizome is yellowish inside, while its apex and the bases of the petiole are purplish.

Another type, the "garendakandala" (S. P. I. No. 17459), also from Ceylon, has obscure greenish lines upon a reddish brown background, except toward the upper part of the petiole; the blade narrow, glaucous blue; the top of the rhizome and extreme base of the petiole white instead of pink.

Another distinct type is the "kiempol poetich" (S. P. I. No. 20947) of Java. In this the petiole is bronze-red in the middle, pale green at the base and apex, with a paler, involute sinus margin. The blade is peculiar in having purple flecks near the petiolar spot and occasional pale-green blotches near the middle, while the veins are dark glaucous green.

DASHEEN VARIETIES.

For reasons previously explained, it is not always easy to distinguish between the dasheens and the taros, for some of the dasheens have a tendency to throw sprouts from the tips of the tubers, while some of the taros produce tuber-like offsets at the surface of the ground. Many forms of the dasheen have been cultivated in China and Japan for centuries, if not for thousands of years. One variety, the Hatake-imo (S. P. I. No. 21649) of Japan, has the corm-like offsets combined into a multiple-headed clump; but, stranger still, each tip throws out not one but an indefinite number of buds. It is possible that the process of close cutting the petiole has finally brought about an abnormal habit in this form. The leaf and petioles of this variety in particular, and of many of the so-called "imos" of Japan in general, are gathered as greens and boiled like spinach, and they are also dried and preserved with salt.[a]

A distinct type of dasheen which was sent under the name *Leucocasia gigantea* (S. P. I. No. 21644), the Hasu-imo of Japan, is so free from the acridity which is common in the vegetative portion of these plants that the petioles may be eaten even without cooking. The color of the petiole varies from a pale green in some of the Japanese forms to a pronounced purplish bronze color; the petiolar spot may be obscure or purplish, as in the taros.

Perhaps the best form of dasheen is the Trinidad (S. P. I. No. 15395). This matures its tubers in about six months from planting, provided the soil and climatic conditions are favorable. Though the tubers are not large (seldom larger than a hen's egg), the prolificness makes up for the small size. Both the tuber and the central rootstock may be used on the table; the inside is very white, though the surface is covered with a mat of coarse, reddish brown fibers. The erect petioles are purplish bronze-green, especially in the middle, while the leaf blade is dark bluish green, with a purple petiolar spot. This variety readily adapts itself to either dry or moist soils, provided they are not baked or acid. Since this variety endures close planting, it is probably possible to obtain upward of 10 tons of roots to the acre with common culture in ordinary soil.[b]

SUMMARY.

There is a vast area of semicultivated and uncultivated land in the Gulf and South Atlantic States which is too wet to admit of the cultivation of general crops, but which is adapted to the root crops discussed in this paper.

The four types of these root crops, namely, yautias, alocasias, dasheens, and taros, are practically new to the agriculturists of America, although most of the varieties discussed here have been under cultivation in other countries for centuries.

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[a] The Midsu-imo (S. P. I. No. 21647), one of the largest tubered of the Japanese dasheens, has yielded in rich, moist soil in an experimental plantation of 35 hills at Gough, S. C., 8½ pounds of roots to the hill. The hills were at a distance of 3 feet, in rows 4 feet apart, and on this basis the yield was at the rate of more than 15 tons to the acre. The length of season was seven months from planting to harvest. Closer planting, which would be of advantage from a cultural standpoint, would probably increase the yield per acre.

[b] The Trinidad dasheen yielded in the experiment at Gough, S. C., in a small plot of 6 hills, an average of 7 pounds to the hill, or at the rate of more than 12½ tons to the acre. A somewhat similar variety from Surinam, the "Sinesie," of which 62 hills were grown, yielded an average of 7.6 pounds to the hill, or at the rate of 13½ tons to the acre. Some other varieties of this type, of which only small plots were grown, yielded at a much higher rate.

These crops require only a moderate amount of attention, but under ordinary conditions it is believed that their yield will be comparatively large. Fertilizers are seldom required; insect and fungous pests are comparatively few; cuttings of the root instead of seeds are employed in propagation.

Many of the varieties are of use as salad plants, though the prime object, especially of the yautia and dasheen varieties, is the production of starch. The tubers of many varieties are suitable for table use, and the roots of nearly all forms may be used as stock food either fresh or when ground into meal. Several varieties which produce small but numerous tubers are particularly adapted for the production of alcohol.

II.—AGRICULTURAL HISTORY AND UTILITY OF THE CULTIVATED AROIDS.

By O. F. Cook.

There can be no question as to the importance of the cultivated aroids. Though a large number of varieties, and even distinct species and genera, are included under this general term, the series may be viewed agriculturally as a single crop of world-wide importance. It is unfortunate that the studies reported upon by Mr. Barrett could not be carried farther, but even this incomplete report contains a very much wider range of information than any other publication on the subject.

The culture of the taro extends from the West Indies across the Pacific islands, Japan, China, the Malay region, Hindustan, Madagascar, and the whole breadth of tropical Africa. The natives of East Africa grow the taro extensively and have many named varieties.[a] Welwitsch reports Colocasia as growing spontaneously in the Portuguese colony of Angola, even in districts where it is not now used by the natives. The taro exists also among the natives of the interior of Liberia, though the eddoes (Xanthosoma), introduced from the West Indies in the last century, are now preferred.

The scientific name Colocasia has been connected through the Greek with an ancient Egyptian word, "culcas." The taro is cultivated in Egypt, but its antiquity in that country was questioned by De Candolle, who also doubted whether "culcas" was really the name of the plant that we now call Colocasia. I have recently learned from Mr. A. Aaronsohn that the taro is grown in Palestine and Syria, especially in the vicinity of Beirut, and that the word "culcas" is still in use among the Arabs as the name of the plant. Mr. Aaronsohn is also inclined to believe that the culture of the taro in Palestine is very old.

The culture of the taro in China is considered by all authorities as very ancient. The Chinese residents of California import considerable quantities of taro from Canton and from Hawaii, and are beginning to produce it in California. There is also said to be a growing demand for it among the white population.[a]

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[a] Dammer, U. Die Gemüsepflanzen Ostafrikas. In Engler's Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete, Berlin, 1895, p. 131. The presence of a variety of Xanthosoma among the cultivated East African aroids is indicated, though the plants have not been thoroughly studied.

Whether the taro also existed in ancient America and thus had a really world-wide distribution in prehistoric times is an interesting question worthy of a careful investigation from the standpoint of ethnology as well as from that of the agricultural study of the varieties. The fact that these cultivated aroids have been so persistently neglected by Europeans lends them an especial interest in the study of primitive agriculture, since we have much greater justification for supposing that their distribution represents the work of primitive man than in the case of plants in which civilized people have been interested. The present tendency to give more careful consideration to such plants and to exchange varieties between remote parts of the world is likely to disturb the present localization of varieties and make it even more difficult to learn their source unless careful studies of the varieties accompany the work of introduction.

There seems to be no record of an introduction of the taro into America by Europeans until very recent times, and yet botanists have reported it as existing in many localities among the natives. The close external similarity of the taro to the yautia renders it very probable that mistakes would be made and prevents our placing any complete reliance upon the reports, even of acknowledged authorities, unless we can know the facts on which their identifications were based. Thus Seemann, who was an eminent and thoroughly competent botanist, reported the existence of Colocasia in Panama with the native name otó, while Mr. Barrett reckons the otó as one of the varieties of Xanthosoma. Varieties having leaves with a closed sinus are reckoned as Colocasia, those with a completely margined open sinus as Alocasia, those with the margin interrupted in the sinus as Xanthosoma. These leaf characters are certainly very convenient in dealing with these varieties that seldom or never flower, but it has to be admitted that such differences are often found among members of the same genus in other groups of plants. The forms reckoned as Xanthosoma appear to be more different among themselves than some of them are from varieties placed in Colocasia. Thus the Palma yautia is very distinct from the other Porto Rican varieties. Its failure to produce tubers, ready production of flowers (Pl. IX, fig. 2), and greater similarity to a species that grows wild in Central America indicate a more recent domestication.

Varieties of aroids with the taro-like leaves are widely distributed among the natives of the West Indies and adjacent parts of the continent, although not nearly so popular in cultivation as many of the varieties of Xanthosoma. In Porto Rico and Cuba the taro retains the supposedly indigenous name "malanga," which would hardly be the case if it had been introduced by the Spaniards. If the natives of the Caribbean region considered it superior to Xanthosoma, it might be thought to have spread amongst them since the discovery, but it is more difficult to understand the wide distribution without popularity, unless we suppose that the taro was formerly more popular than at present and is being displaced by Xanthosoma. If the taro was not already in America before the arrival of Europeans it seems more likely to have been introduced from Africa than from the Pacific islands. Importers of slaves from Africa found it to their advantage to supply the negroes with their accustomed foods. The African oil palm and the cola nut, as well as certain varieties of sweet potatoes and yams, are supposed to have been established in the West Indies during the period of the slave trade. The name "malanga" itself is similar to many African words. One of the East African names of the taro is "malombo."

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[a] Blasdale, Walter C. A Description of Some Chinese Vegetable Food Materials and Their Nutritive and Economic Value. Bulletin 68, Office of Experiment Stations, U. S. Dept. of Agriculture, 1899, p. 13.

If it be true, as Mr. Barrett seems to think, that Alocasia as well as Colocasia has numerous American varieties, it becomes reasonable to suppose that the three principal types of cultivated aroids, Xanthosoma, Colocasia, and Alocasia, were originally domesticated in America. The American nativity of Xanthosoma has not been questioned, but the greater importance of Colocasia and Alocasia among the Polynesians has made it appear that they must have originated in the Pacific islands or the Malay region. The same argument has been applied to the coconut palm, which is certainly a native of America, though it has usually been ascribed to the shores of the Pacific and Indian oceans because of its much greater importance in the East Indies than in the West.

The domestication of root crops characterized an early epoch in the development of primitive agriculture in tropical America. This is shown by the large series of root crops that were domesticated in America. In addition to the cultivated aroids, there were sweet potatoes (Ipomoea), arrowroot (Maranta), cassava (Manihot), yams (*Dioscorea alata*), apio (Arracacia), lleren (Calathaea), potatoes (*Solanum tuberosum*, *S. commersoni*, and other species), ullucus (*Ullucus tuberosus*), achira (*Canna edulis*), masua (*Tropaeolum tuberosum*), oca (*Oxalis crenata*), and the Jerusalem artichoke (*Helianthus tuberosus*). The yam bean or jicama (Pachyrhizus) and the chayote (Chayota or Sechium) were also grown as root crops, though propagated from seeds.

In addition to this series of plants that have become known as root crops and are usually mentioned as such in botanical works of reference, there are records of several other species that are planted as root crops in South America. A list of these has been collected recently by Prof. H. Pittier, of the Bureau of Plant Industry, including *Polymnia edulis*, *Lepidium meyenii*, *Portulacca grandiflora*, and several other plants whose botanical names and agricultural possibilities are still unknown.

The root crops that were domesticated in America stand in distinct contrast with Old World root crops, both in number and in character. The species cultivated in the Old World were relatively few, mostly the seed-propagated garden vegetables of temperate regions, such as radishes, turnips, beets, parsnips, carrots, etc. The temperate root crops domesticated in the Old World were mostly capable of being eaten raw, as though they had been used first by people unaccustomed to use fire for cooking vegetables. The root crops that were domesticated in America are not eaten raw by the natives. Many of them are disagreeably acrid in the raw state, like the aroids, or even positively poisonous, like the cassava. Very few new types of plants appear to have been domesticated as root crops in the Old World Tropics, and none of them have attained the prominence of several of the American species. The banana appears to have been domesticated first as a root crop, and some of the varieties are still cultivated for their rootstocks in New Caledonia and in East Africa.

The greater antiquity of the domestication of plants in America is to be inferred from the fact that many of the cultivated species are not known in the wild state, while in the Old World there are very few species, if any, that do not have wild representatives that still appear closely similar to the domesticated forms. In the case of the yautias the American nativity is clearly indicated by the wild species of Xanthosoma. One of these grows abundantly in Guatemala and is eaten by the natives in times of scarcity of other food. Yautias are also cultivated in Guatemala, but rather sparingly, Indian corn being the chief staple in all parts of the country. The varieties of Xanthosoma cultivated in Guatemala appear quite distinct from the common wild species. The wild plant is larger and has a lighter green foliage, and the rootstocks that provide for the vegetative propagation of the plant are very slender, only about the diameter of an ordinary lead pencil, instead of the large, fleshy, tuberous rootstocks produced by the cultivated sorts. This wild species has a considerable similarity to the variety cultivated in Porto Rico under the name "yautia palma," but has a shorter and thicker spadix with a less ample spathe.

The abundance of the wild xanthosomas in the mountainous parts of Guatemala, including the volcanic districts, makes it easier to understand how a poisonous plant might come to be used and finally protected, propagated, and cultivated by primitive man. The agricultural development would come about very naturally and gradually after the making of the simple discovery that these acrid plants could be eaten after they had been kept for a time in boiling water. This discovery was possible in many places in tropical America in the very early stages of human progress, before cooking utensils were used and even before fire had been definitely adopted by primitive man. Springs of hot water are numerous and are shown by special abundance of ancient remains to have been centers of population in primitive times. Former association with hot springs is also suggested by the habit of many of the Indians, such as the Kekchis of eastern Guatemala, to drink only hot water.

An alternative possibility has to be admitted, that the taro plant, like the banana, might have been brought to America from the Pacific islands in prehistoric times and might have fallen into comparative disuse as the result of the discovery in America of the xanthosoma, which seems to be a better plant for general agricultural purposes. There is good historical evidence that the banana, which certainly originated in the Old World, had been brought to America before the Spanish conquerors arrived. No such direct testimony is likely to be secured regarding the taro, which attracted relatively little attention from the early historians of Spanish America. We have to rely upon the general considerations that it is not likely to have been brought by the Spaniards, and still less likely to have been adopted by the Indians, who are very slow to take up the cultivation of any new plant unless it appears to have a very distinct advantage. The Polynesian method of cultivating the taro in pools or swamps is not known to be applied to the plant anywhere in America. Mr. David Fairchild, of the Bureau of Plant Industry, states that the Polynesian system of planting the taro in the muddy soils of swamps or artificially flooded places is in use in the island of Madeira, introduced, doubtless, by the natives of the island who have lived in Hawaii (see Pl. X). The nearest approach to this system is seen when the plants are scattered along the banks of small streams. Many yautias are raised in Porto Rico on very steep, rocky slopes of mountains, where the soil is very shallow and irrigation is quite out of the question. (See Pl. IX, fig. 1.)

Whether or not we agree with Mr. Barrett regarding the prospective commercial importance of the aroids or their profitable cultivation in the United States, the study of them is eminently justified by two practical considerations, (1) that they are extensively used as food by millions of natives of tropical countries and (2) that they are worthy of much more careful consideration by all Europeans who undertake to settle or reside in tropical countries.

The Tropics afford a great variety of fruits, though there are few localities where the traveler's expectations of profusion are realized. But if fruits are usually to be reckoned as scarce, there is often a downright famine of vegetables. Not only on the Isthmus of Panama, but in many other parts of the Tropics where railroad building and other improvements are being attempted by men from Europe and the United States, the deficiency of fresh vegetables is recognized as a practical difficulty which seriously interferes with comfort, health, and efficiency.

The Department of Agriculture receives many letters from American residents of tropical countries asking for information and seeds of varieties of temperate vegetables that will grow in the Tropics. In some regions moderate success with a few of the temperate types of vegetables is possible if special care is used and after sufficient experience has been accumulated. Varieties better suited to tropical conditions are being discovered or introduced from other tropical countries. The success of the Chinese gardeners with some of their seeds from Canton shows that their varieties and methods of culture are worthy of our careful consideration.

In many cases the most practical advice that can be given to persons newly established in tropical localities is to study and make use of the indigenous tropical vegetables, of which these yautias, taros, etc., form excellent representatives. These plants will thrive and produce abundantly under extreme tropical conditions where most of our temperate vegetables will refuse to grow and the others can be expected to produce only the most indifferent results. The acrid substances and milky secretions render the aroids immune to many of the diseases and insect pests that interfere with the cultivation of other kinds of plants that lack such protection.

Propagation by rootstocks is an especial advantage under tropical conditions, since it avoids the difficulties of germinating, transplanting the seedlings, and caring for the plants in their tender early stages. With sufficient water the cultivated aroids may be expected to hold their own with any other crop, and they will also thrive in places too wet for most of our cultivated plants.

The agricultural advantages make it all the more desirable that residents in the Tropics should become thoroughly acquainted with the cultivated aroids. Many people think they have tried the tropical vegetables who have not really done so. It is necessary to learn how to use a new plant, as well as to learn how to grow it, and one must persist until he has had a fair opportunity of testing his own taste. The tendency to condemn any unfamiliar dish is very general, whereas the same flavor that seemed so objectionable at first may appear quite attractive after we have become accustomed to it.

This is true of the aroids used as garden vegetables. By people who have become familiar with yautias or eddoes they are often recommended as better than potatoes. But if one expects too close a similarity he is disappointed. Instead of the soft, mealy, white, bland-tasting "mashed potato," one finds a much firmer material of a somewhat yellowish or grayish color and a distinct, slightly nutty flavor. Nobody would be likely to mistake eddo for potato, and if potatoes were expected eddoes might be a distinct disappointment. But if we give the eddo a fair trial on its own merits, it may hold its own with the potato in our gastronomic affections. We may be surprised to find ourselves as willing to have eddoes served as potatoes or to find that we miss the eddoes at home as much as we did the potatoes in Africa.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 165.

B. T. GALLOWAY *Chief of Bureau.*

APPLICATION OF SOME OF THE PRINCIPLES OF HEREDITY TO PLANT BREEDING.

BY

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Agriculturist in Charge of the Office
of Farm Management.

Issued December 31, 1909.

239490
13.1.30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

BUREAU OF PLANT INDUSTRY.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 28, 1909.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 165 of the series of this Bureau the accompanying manuscript entitled "Application of Some of the Principles of Heredity to Plant Breeding." This paper was prepared by Mr. W. J. Spillman, Agriculturist in Charge of the Office of Farm Management of this Bureau. Great progress has been made during the past ten years in investigations relating to the principles involved in the improvement of plant varieties and the production of new varieties by cross-breeding. Thus far there has been no general statement of the principles applicable in this work especially designed for the use of the actual breeder. The present paper is an attempt to set forth in an orderly manner what is known of the effect of selection on different types of plants and the possibilities of cross-breeding for the purpose of producing new varieties, as understood by the author.

The paper is submitted and recommended for publication in accordance with the fixed policy of this Bureau of giving its men full opportunity of presenting results of scientific and practical interest from different points of view.

The author wishes to acknowledge the helpful criticism of Prof. C. V. Piper, and especially of Assistant Secretary Willet M. Hays, both of whom have carefully read the manuscript and have made many valuable suggestions in the treatment of the various topics.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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APPLICATION OF SOME OF THE PRINCIPLES OF HEREDITY TO PLANT BREEDING.

INTRODUCTION.

While the discussion in these pages of principles that may be applied in the improvement of crops by breeding and selection will involve principles other than those discovered by Gregor Mendel, the fact that Mendel's principles are somewhat complex renders it necessary to state them in a general way before taking up the subject of plant improvement.

DOMINANCE AND RECESSIVENESS.

The simplest of the principles discovered by Mendel is that which is usually referred to as the "law of dominance." This principle should hardly be called a law, because it is in no wise general and in very few cases is dominance absolute. The phenomena of dominance and recessiveness may be illustrated by a few examples.

If a red-flowered variety of the common garden pea be crossed with a white-flowered variety, the progeny will have red flowers. According to Mendel's original conception a cross of this kind brings together two antagonistic characters. The progeny inherit the red flower color from one parent and the white flower color from the other. It therefore has both these characters. It happens, however, that the red character predominates over the white and comes to expression while the white character is not visible in the cross-bred individual. Mendel suggested that a character behaving as the red character does in this cross should be called a "dominant character," while one behaving as the white character in this cross should be called a "recessive character."

If we cross a bearded variety of wheat with a smooth variety, that is, one that has no beards, the hybrids thus produced either have no beards or the beards will be only slightly developed. Hence, we say that smoothness is dominant to beards, at least partially, or, which means the same thing, that beards are recessive to smoothness. The cross between polled and horned breeds of cattle has no horns, though a small proportion of such cross-bred animals may have "scurs," that is, imperfect horns. Hence, we say that horns are recessive and the poll character dominant. Many other cases might be cited to illustrate dominance and recessiveness of hereditary characters, but the above examples will serve to illustrate the principles sufficiently here.

While it is not uncommon for a character to be dominant or recessive in a cross, it is seldom that dominance is absolute. The presence of the recessive character can usually be detected, and in some cases very easily. Thus, in the cross between bearded and smooth wheat the hybrids usually show a slight tendency to be bearded. Likewise, as already stated, the cross between horned and polled cattle may have scurs. It frequently happens that instead of either of two opposite characters being dominant we get a form intermediate between the two parent forms. Thus, in the cross between ordinary long-headed wheat and the short-headed club wheats of the Pacific coast the hybrid has heads of intermediate length, though they are much more like club wheat than they are like the ordinary kinds, so that the club character is at least partially dominant. In certain crosses between red-flowered and white-flowered ornamental plants the hybrids are pink.

In not a few instances a hybrid is altogether different in some characters from either of its parents. Thus, in the case of the cross between a certain red primrose and a certain nearly related white variety the hybrid is purple.

We thus have every gradation between perfect dominance of a character over its opposite and cases in which the hybrid is unlike either parent.

SEGREGATION.

We have seen that when two naturally opposite characters meet in the same individual one of them may be completely dominant, as the pole character in many individuals of the cross between polled and horned cattle, or the crossbred individual may exhibit a character intermediate between the opposed characters of its parents, as the pink color of certain hybrids between red-flowered and white-flowered plant varieties, or the hybrid may exhibit a character different from the corresponding characters of either of its parents, as the purple color of hybrid primroses produced by crossing certain red and white varieties.

In a pure race of plants having red flowers we may assume that each individual which bears seed transmits to all its seed the tendency to produce red flowers. Likewise, in a pure white-flowered race, each individual transmits to its progeny the tendency to produce white flowers. But what of the hybrid between two such races? What does this hybrid transmit to its offspring? Let us consider the case of the hybrid primrose having purple flowers. The facts are, as found by experiment, that this purple hybrid produces three kinds of progeny. About one-fourth of the seed produced by this hybrid produces plants having red flowers like those of the red-flowered parent of the hybrid. Another fourth have white flowers, while the remaining half have purple flowers. Furthermore, the red and the white flowered plants of this second generation will reproduce only red or white progeny, as the case may be; that is, they behave exactly like pure red or pure white races. On the other hand, every one of the purple-flowered plants will produce in the next generation three kinds of progeny as before. One-fourth of the progeny of these purple-flowered plants will have red flowers, one-fourth of them white flowers, and half of them purple flowers. This experiment was continued by an English florist for fifteen years, always with the same result. The purple always split up into one-fourth red, one-fourth white, and one-half purple, while the reds and the whites thus produced always behaved like pure races of red or white. From these facts we infer that in self-fertilized species an individual which is hybrid with reference to a particular pair of characters tends to produce progeny one-fourth of which is of pure race like one of the parents of the hybrid, another fourth of pure race like the other parent, while the remaining half is hybrid like the original hybrid itself.

Mendel suggested that the cause of these peculiar phenomena is that the hybrid produces two kinds of ovules and two kinds of pollen, the one kind of ovule and one kind of pollen being exactly like those of one of the parents of the hybrid so far as the one character under consideration is concerned, the other kind being like those of the other parent. Let us see how this hypothesis fits the facts.

Suppose the hybrid does produce two kinds of ovules in equal numbers, one of which carries the potentiality of the red flower color, the other that of the white, and two kinds of pollen differing in a similar manner. Let us designate the ovules and pollen carrying red by the letter *R*, and those carrying white by *W*. Let us first consider what happens to the ovules of type *R*. These ovules are offered both *R* and *W* pollen in equal quantities. The chances are, therefore, that half the *R* ovules will be fertilized by *R* pollen and the other half by *W* pollen. In the first of these cases, we have *R* ovules fertilized by *R* pollen, which would, of course, give pure red individuals. For convenience, we may designate these individuals resulting from the fertilization of *R* ovules by *R* pollen as *RR* individuals. Since half of the ovules produced by the hybrid are supposed to be of type *R* and since half of these are fertilized by *R* pollen it follows that one-fourth of the progeny of the hybrid will be pure reds. Similarly, the *W* ovules are offered both kinds of pollen, and the chances are that half of these ovules, or about half, will be fertilized by *R* pollen, the other half by *W* pollen. The latter half being fertilized by pollen of their own kind result in pure white individuals, which we may, for convenience, designate as *W W* individuals, thus indicating that both the ovules and the pollen which gave rise to these individuals had the character *W*. The *W W* individuals also constitute one-fourth of the progeny of the hybrid. The remaining half of the progeny result from the fertilization of one kind of ovule by the opposite kind of pollen, thus giving hybrids like the original hybrid, which we may designate by the formula *R W*.

We thus see that the supposition that the hybrid produces two kinds of pollen, one like the pollen of the red variety and the other like that of the white, and two kinds of ovules, differing in a similar manner, fully explains the phenomena observed by the breeder of the purple primrose. This hypothesis is further substantiated by the following facts. If we apply the pollen of the hybrid to the stigmas of the red variety, half the progeny thus obtained will be red and half purple. This is easily understood if the hybrid produces two kinds of pollen in equal quantities. All the ovules of the red variety have the character *R*. If half the pollen of the hybrid carries *R*, then half the progeny will be *RR*, or pure red. If the other half of the pollen carries *W*, then the other half of the progeny will be of the type *R W*. That the hybrid produces two kinds of ovules is shown also by the fact that if we apply pollen of the red variety to the stigmas of the hybrid, half the resulting progeny will be red and half purple.

We may accept the hypothesis, therefore, that a hybrid plant whose parents differ in respect to a single character pair produces two kinds of ovules and two kinds of pollen, one kind being like those of one of its parents, the other kind like those of its other parent.

If a hybrid which has in its cells two characters which are naturally the opposite of each other can not produce ovules and pollen with both of these characters in the same ovule or pollen grain, then it follows that these two opposite characters can not be transmitted together. They remain together in the cells of the hybrid well enough, but they fall apart somewhere in the process of producing reproductive cells. Let us now inquire how this segregation of the members of a pair of opposite characters into different ovules and different pollen grains, which takes place in hybrids, may occur. In the cells of a plant we have, first, the outer covering, or cell wall. Within is the nucleus, between which and the cell wall lies the cytoplasm, consisting of a semi-liquid ground substance, in which lies the network of the cytoplasmic reticulum, in the meshes of which occur various small bodies called collectively the cytoplasts. Within the nucleus, which is separated from the cytoplasm by the nuclear membrane, are found the chromosomes, which are small bodies of living substance lying in the nuclear sap or ground substance of the nucleus. We must seek for the potentialities of the hereditary characters either in some of these cell organs or in their relations to each other. The behavior of the chromosomes is such as to suggest strongly that they are the seat of at least some of the potentialities in question. The work of Prof. E. B. Wilson and his pupils and others indicates that in certain animals certain identifiable chromosomes are responsible for the differences between the sexes, at least for the primary sexual differences. Several other hereditary characters not directly related to sex behave in such manner as to indicate clearly that they bear to the chromosomes a relation similar to that which sex bears to these cell organs. It is highly probable, therefore, that many hereditary characters depend in some way not yet understood on the chromosomes. In fact, when we describe the known behavior of the chromosomes we describe the known behavior of Mendelian characters.

It is not necessary in this discussion to consider the various theories regarding the relation of hereditary characters to the organs of the cell. The behavior of the characters studied by Mendel and of hundreds of characters investigated by others leaves no doubt that these characters depend in some way on definite cell organs. This does not necessarily imply that each hereditary peculiarity of a race is represented by a distinct body in the germ cells. A given peculiarity may be due to peculiarities in the composition or the physiological behavior of several cell organs. This much, however, seems to be certain: When two races differ in respect of a character and when the hybrid between these races produces two kinds of reproductive cells, one of which is like the reproductive cells of one of its parents and the other like those of the other parent, as is the case in primroses just cited, then the difference between these two races is due to differences in a single cell organ or to a group of such organs which act together at all times as if they were inseparable. In hybridization we are dealing with differences between organisms, and these differences are due to differences between corresponding cell organs in the different races. For instance, suppose we have two races of plants which differ only in the fact that one of them has red flowers and the other white and that the hybrid between them produces two kinds of pollen, one of which is identical with the pollen of the red variety and the other with that of the white variety. We know that the real difference between these varieties lies in the fact that one of them produces red coloring matter and the other does not. We may therefore assume that in the white variety a certain cell organ fails to perform a function which the corresponding organ in the other variety does perform. We may call this function which is performed in the red variety the "determiner" for red. In the white variety this determiner is absent, although the cell organ which performs this function in the other variety may be present in the white variety. In this variety it fails to perform the function necessary to the production of red coloring matter.

We should not get the idea that red coloring matter is due wholly to a single function of a single body, for such is probably not the case. It may be necessary for several cell bodies to cooperate in the production of this substance. In the white-flowered variety all of these bodies may function properly except one, the failure of the one body to perform its appropriate function being responsible for the nonproduction of the red coloring matter. But when we are dealing with a cross between these two varieties it is the one point in which they differ that concerns us, and we shall use the word "determiner" to apply to this point of difference. Hence, we say that in the one variety the determiner for red is present and in the other it is absent.

Although the determiner of a character is assumed to be a function of a definite body, or of several such, we shall not attempt in what follows to distinguish in all cases between these bodies and their functions. In general, we shall represent the determiner for a character by a capital letter, usually the initial letter of the name of the character. Thus, capital *R* may be taken as the symbol of the determiner for red coloring matter, but this symbol will be used indifferently for the function which produces red and for the body or group of bodies which has this function. For the absence of this determiner in the white variety we shall use the corresponding small letter. Thus, *r* may be considered in what follows as representing the absence of the function *R*, or it may be considered to represent the body present in the white variety that fails to perform the function which is performed by the corresponding body in the red variety.

We are now ready to explain why the hybrid between a red and a white variety of primrose produces two kinds of reproductive cells, one like those of the red variety and one like those of the white—at least, to offer an hypothesis that agrees with the facts.

The red variety has inherited the determiner for red from two parents. The condition of this determiner in the red variety may therefore be represented by the symbol *RR*. This means that in the cells of a plant of the red variety there are two determiners for red. The corresponding determiners in the white variety may be represented by the symbol *rr*, which may be taken as representing two bodies, neither of which performs the function necessary to the production of red coloring matter, but which correspond in the white variety to homologous bodies which do perform this function in the red variety. The symbol of the hybrid would, of course, be *Rr*, in which *R* represents the "active" determiner derived from the red variety and *r* the nonactive one from the white variety. In ordinary growth, when a body cell has attained its maturity and divides into two cells it is supposed that each character determiner present divides, one part going into one of the new cells, the other into the other. Thus, if a mature cell contains the determiners *R* and *r*, then each of the new cells formed by its division likewise contains both *R* and *r*. Thus every cell in the body of the individual may be supposed to have both *R* and *r* in it. This is certainly true of those cells which form the direct line of descent from the original fertilized ovule to the new ovules and pollen grains produced by the individual. The cells in this line of descent are called collectively the germ cells, a term which we shall find convenient to use.

If ovules and pollen cells were formed by ordinary cell division such as that described above, it is clear that every ovule and every pollen grain produced by the hybrid *Rr* would contain both *R* and *r*. But the facts indicate that only half the ovules and half the pollen grains contain *R*, while the other half contain *r*. There must be, then, a cell division somewhere in the line of descent which differs from the ordinary type of cell division, and there is unmistakable cytological evidence that such is the case. Just before the formation of ovules and pollen grains (in fact, in next to the last division of the germ cells) we find a cell division in which the chromosomes do not divide in the usual manner. Instead they unite in pairs, forming double, or bivalent, chromosomes. This union of chromosomes into pairs reduces the number of chromosomes to half what it was before. Then, when the cell divides, these large chromosomes divide, presumably into the two halves which united to form them. If we call the large double chromosomes mother chromosomes and the small ones into which they separate daughter chromosomes, then in this cell division one of the daughter chromosomes passes to one of the newly formed cells, while the other passes to the other cell. Now, if these chromosomes either themselves are the bodies whose functions are our "determiners," or if they contain smaller bodies which are responsible for the determiners, we have at once an explanation of the fact that our hybrid produces two kinds of ovules and two kinds of pollen. For in this cell division, which is called the reduction division because in it the number of chromosomes is reduced by half, our determiners *R* and *r* may be assumed to reside in separate chromosomes which unite to form a single bivalent. While cell division is taking place this bivalent chromosome again separates, *R* passing into one daughter cell and *r* into the other. If the determiners *R* and *r* are not simply the functions of chromosomes themselves they at least pertain to bodies which at some point in the line of descent of the germ cells behave just as we know the chromosomes do behave—that is, at some cell division *R* and *r* unite into a pair, and when division occurs *R* goes one way and *r* the other. Two determiners which thus behave toward each other are said to constitute a Mendelian pair.

Most Mendelian pairs consist simply of the presence of a given determiner on the one hand and the absence of that determiner on the other. Furthermore, the determiner which represents the presence of a character is in nearly all cases dominant over the determiner which represents the absence of that character. Dr. C. B. Davenport, of the station for experimental evolution of the Carnegie Institution, found that in poultry practically all the character pairs known show this relation; i. e., presence of a character dominant and absence of it recessive. We have seen, however, that there are some exceptions to this rule, since the poll character is dominant to horns and beardlessness in wheats is dominant to beards. The difference between polled and horned cattle is the absence of horns in one and their presence in the other.

But cases are known in which this simple relation of presence and absence of a character does not constitute the Mendelian pair. For instance, if Barred Plymouth Rock females be mated with Indian Game males all the female progeny of this mating will be black, while all the males will be barred like the mother. Data accumulated by the writer and an extended series of experiments performed by Mr. H. D. Goodale[a] indicate that the female Barred Plymouth Rock produces two kinds of eggs. One of these kinds is destined to produce females, and these female-producing eggs do not have the determiner for barring in them. The other kind is destined to produce males, and these eggs do have the barring factor. In this case it appears, therefore, that the determiner for femaleness and that for barring form a Mendelian pair. Wilson has apparently shown that the determiner for femaleness in many animals is a certain chromosome or group of chromosomes that always act as a unit. If we assume that the determiner for barring is another chromosome which unites with the sex element to form a bivalent in the reduction division we have at once an explanation of the behavior of the determiner for barring. In the germ cells of the female Barred Plymouth Rock we have the two elements *F*, which causes the individual to be a female, and *B*, which gives the barring on the feathers. In ordinary cell division both of these elements divide; but in the reduction division *F* and *B* unite into one body. This body then separates as the cell divides, so that one of the daughter cells contains *F* and the other *B*. Such a female therefore produces two kinds of eggs, one containing the determiner for the female sex, the other that for barred feathers.

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[a] See Science, June 25, 1909.

Several other cases are known in which Mendelian pairs are formed of determiners for characters that are apparently unrelated. Such a case occurs in the purple primrose previously mentioned. We may explain the phenomena presented by this hybrid as follows: Let us assume that the original wild species from which the red and the white races in question are descended had purple flowers and that this purple color was due to two functions of the same cell organ. One of these functions, which we may designate as *R*, had to do with the production of red coloring matter, while the other, which we may designate as *P*, changed red into purple, somewhat after the manner in which an alkali changes litmus from red to blue.[a] The determiners *R* and *P* were functions of the same cell organ, probably a chromosome. Since this body had two functions we may represent it by the symbol *R–P*, the hyphen indicating that the two functions belong to the same cell organ. Since there is a pair of these bodies in each cell, the complete status of these determiners in the body cells would be represented by *R–P R–P*.

Now, let us suppose that in one section of the species the determiner *R* becomes latent or is lost. Our formula then becomes *r–P r–P*, or simply *PP* in this race, which would, of course, have white flowers, since the determiner for red is absent. In another section of the species the determiner *P* vanishes, leaving *R–p R–p* or simply *RR*. Now, when we cross these two races we bring the determiner *r–P* into the same cell with *R–p*. Here we have the red coloring matter produced by one determiner and converted into purple by the other. This would account for the purple color of the hybrid, as well as the red of one variety and the white of the other. Other cases of Mendelian pairs of this nature will be mentioned later.

In this purple hybrid we may consider that we have one character pair consisting of *R* from the red parent and *r* from the white parent, so that this pair consists of red and absence of red, while along with it we have another pair consisting of *P* from the white parent and *p* from the red parent, so that this pair consists of the presence of *P* and the absence of *P*. But the fact that *P* and *R* can not be transmitted together indicates that *R* and *p* pertain to the same cell organ, and that *r* and *P* pertain to the Mendelian mate of this organ. Since most Mendelian character pairs consist of determiners one of which represents the presence of something and the other the absence of the same thing, we shall, in general, use for such pairs of characters in hybrids symbols consisting of a capital letter and the corresponding small letter, the capital letter standing for presence of the character and the small letter for its absence. Thus, in the cross between red and white peas, since the difference between these varieties consists in the presence of red color in one and its absence in the other, we represent the hybrid as *Rr*. Since the hybrid itself is red in this instance, this formula is logical; it would naturally be red because of the presence of *R*. But, as previously stated, there are cases in which the absence of a character is dominant in the hybrid between races one of which has the character and the other does not. Thus the hybrid between polled and horned cattle is polled. Here the formula for the horn determiner in the pure horned breed would be *HH;* in the pure polled breed, *hh;* and in the hybrid, *Hh*. But since the determiner *H* does not succeed in producing horns in the hybrid and the hybrid therefore has the appearance of its polled parent we may write the formula for the hybrid as (*H*)*h*, to show these facts. Similarly, the hybrid between bearded and smooth wheat would be represented by (*B*)*b*.

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[a] See article by Shull in American Naturalist, July, 1909.

Cases like the purple hybrid primrose are so rare that we do not need to use any particular symbol to indicate that the hybrid is unlike either parent.

The question why these characters, horns in cattle and beards in wheat, do not develop when represented by only one active determiner is an interesting one, and is very ably discussed by Doctor Shull in the July, 1909, number of the American Naturalist. The fact probably is that in these hybrids the determiners *H* and *B* are not latent, but that single determiners are not able to produce that chemical condition in the cell which is necessary for the development of these characters. In pure horned cattle and pure bearded wheat, where there are two active determiners for each of these characters, the proper condition for the development of these characters is brought about.

In general, a hybrid produces three types of progeny with reference to each pair of characters in which its parents differ. The hybrid between red and white varieties of peas produces two kinds of pollen, which we may designate as *R* pollen and *r* pollen. It produces two corresponding types of ovules. On the average, half the *R* ovules are fertilized by *R* pollen, so that one-fourth of the progeny of such a hybrid is of the type *RR* or pure red. Likewise, half the *r* ovules are fertilized by *r* pollen, giving *rr* individuals, which constitute one-fourth of the second generation. The remaining half of the *R* ovules meet *r* pollen and the remaining half of the *r* ovules meet *R* pollen, giving in each instance the combination *Rr*, which constitutes half the second generation. If *R* is completely dominant the types *RR* and *Rr* can not be distinguished, since the latter has red flowers like those of type *RR*. Hence, where dominance is complete the second generation appears to consist of only two types. One of these types shows the dominant character, the other the recessive character, and the dominant type is three times as numerous as the recessive. Thus we arrive at the well-known Mendelian ratio of 3:1, or three dominants to one recessive in the second generation of a hybrid.

In the above second generation the two types *RR* and *rr* are seen to consist of like things united, while the type *Rr* consists of unlike things united. Types *RR* and *rr* are said to be homozygote, a term which means "like things united," while *Rr* is said to be heterozygote, which means "unlike things united." An individual is said to be homozygote with reference to a given character when the cells of that individual contain two determiners for the presence of that character. If its cells contain only one determiner for any character it is said to be heterozygote for that character. Thus a bearded wheat is homozygote for beards, a pure race of smooth wheat is homozygote for absence of beards, while a cross between a bearded and a smooth race is heterozygote for beards.

ALLELOMORPHISM.

The term "allelomorph" was introduced by Prof. William Bateson, of Cambridge, England, one of the leading investigators of Mendelian phenomena. It is derived from two Greek words, one of which means "one another" and the other "form." We may say that it means "corresponding forms." What we have called a "pair of determiners" Bateson calls a "pair of allelomorphs." The term "allelomorph," however, has a wider application than "determiner;" it may mean characters themselves as well as the determiners of those characters. To say that one character is allelomorphic to another means simply that the two characters when brought together in the same individual form a Mendelian pair and hence fall apart when reproductive cells are produced. Thus, a pair of allelomorphs is what we have been calling a "pair of Mendelian characters." Hence, the term "allelomorph" is frequently used simply to mean a Mendelian character; that is, a character which obeys Mendel's law of segregating from its mate in the reduction division.

The term "gamete" is also a very convenient one which we shall have occasion to use frequently. It simply means a reproductive cell, such as an ovule, a pollen grain, an unfertilized egg, etc.

LAW OF RECOMBINATION.

The third and most important principle discovered by Mendel[a] is the fact that, generally speaking, when two or more "pairs" of characters are present in the same hybrid these pairs are independent of each other, so that one member of a given pair may be transmitted with either member of another pair. The results of this important discovery are shown in Table I, which illustrates the cross between Polled Durham and Hereford cattle.

As is well known, Polled Durham cattle have colored faces and no horns, while Herefords have horns and white faces. The white face of the Hereford seems to be due to the presence of a determiner which controls the distribution of color over the body. We thus represent white face by *W* and colored face by *w*, that is, absence of white face. As before, the poll character is represented by *h* and the horn character by *H*. White face is dominant to colored face in this cross. The complete formulæ for these two pairs of characters in the body cells are, therefore—

In pure Hereford cattle, *HHWW*.
In Polled Durham cattle, *hhww*.
In the cross, (*H*)*hWw*.

The cross has the white face but no visible horns, though it may have scurs.

The squares in the upper part of Table I represent germ mother cells dividing in the reduction division. In this division each pair of characters is separated. Thus, the pair *Hh*, both members of which have been present in every cell of the body of the hybrid, is here separated, *H* going to one daughter cell and *h* to the other. In the cross here under consideration we have a second pair of allelomorphs, namely, *Ww*. When a given mother cell divides, the two pairs of allelomorphs may be arranged as in the left-hand square at the top of Table I, in which case *H* and *w* go together into one daughter cell, while *h* and *W* go into the other. Such a division gives two kinds of gametes, the formulæ for which are, respectively, *Hw* and *hW*.[b] Or the two pairs of allelomorphs may be arranged as in the right-hand square of Table I, in which case *H* and *W* go to the same daughter cell, while *h* and *w* go to the other, giving two kinds of gametes having the respective formulæ *HW* and *hw*. There are, in all, therefore, four kinds of gametes that a hybrid individual of the type here under consideration can produce, namely, *Hw*, *hW*, *HW*, and *hw*. In the first of these four types of gametes, namely, *Hw*, we find horns being transmitted with colored face; in the third, *HW*, horns and white face are transmitted together. Likewise, in the second type, *hW*, we have the poll character and white face together, while in type four, *hw*, we have the poll character and colored face.

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[a] The first is the so-called "law of dominance," though it is hardly entitled to rank as a law; the second is the law of segregation of character pairs.

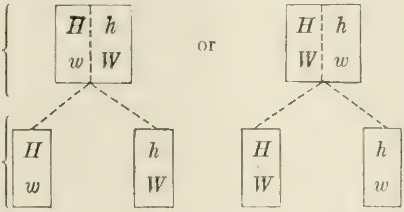
[b] The gametic formula *Hw* does not represent a pair of determiners. It represents two determiners, one of which is from one pair and the other from another pair. We do not have pairs of determiners in gametes, i. e., in reproductive cells. The pairs separate in the reduction division, and a gamete never has both members of the same pair.

Since in the reduction division either of the two possible arrangements of the two pairs of allelomorphs is just as likely to occur as the other, one of them will occur in about half the cells and the other in the other half. We thus get all four types of gametes in equal numbers in every hybrid animal of this character. In the male this is actually realized, for millions of gametes are produced. But in the female only a few reproductive cells are formed, but these few are as likely to be of one type as another. Hence, on the average for a large number of such females, the four types of gametes will occur equally often. In the middle part of Table I we have all the possible, and equally probable, unions that can occur between the gametes of the two sexes. Thus the *Hw* gametes of the female are offered four kinds of sperm in equal numbers. Hence, on the average one-fourth of these *Hw* ovules will be fertilized by *Hw* sperm, giving individuals of the next generation of the type *HHww*. Another fourth will meet *hW* sperm, giving individuals of the type *(H)hWw*, and so on.

TABLE I.—*Cross between Polled Durham and Hereford cattle and its results.*

Reduction division as it occurs in the cells of the first-generation hybrid.

The four types of reproductive cells produced by first-generation hybrids.



Or simply *Hw*, *hW*, *HW*, *hw*.

The sixteen possible, and equally probable, matings to produce second-generation hybrids are as follows:

Gametes of male.

Gametes of female.	*Hw*	*hW*	*HW*	*hw*
Hw	1 *HHww*	2 *(H) hWw*	3 *HHWw*	4 *(H) hww*
hW	5 *(H) hWw*	6 *hhWW*	7 *(H) hWW*	8 *hhWw*
HW	9 *HHWw*	10 *(H) hWW*	11 *HHWW*	12 *(H) hWw*
hw	13 *(H) hww*	14 *hhWw*	15 *(H) hWw*	16 *hhww*

The nine different combinations and their relative frequency follow:

1 *HHWW*.	2 (*H*) *hWW*.	1 *hhWW*.
2 *HHWw*.	4 (*H*) *hWw*.	2 *hhWw*.
1 *HHww*.	2 (*H*) *hww*.	1 *hhww*.

The sixteen formulæ in the squares in the middle of Table I show the results of these sixteen unions. It will be seen that some of these matings are alike; for instance, 2, 5, 12, and 15; 3 and 9; 4 and 13. There are only nine different kinds, as shown in the lower part of Table I. These nine different combinations occur in the relative frequencies shown in the numbers preceding each of the nine in the lower part of Table I. Thus, one-sixteenth of the progeny will represent the combination *HHWW*, four-sixteenths the combination (*H*)*h Ww*, and so on.

Table II shows the results of a more complex cross which the writer made while connected with the Washington Agricultural Experiment Station, Pullman, Wash. It is a cross between two varieties of wheat, one of which was a winter wheat that lodged easily (that is, had weak straw) and had open chaff, and thus when ripe shattered its grain easily. The other was a variety of spring wheat that did not lodge and had tightly closed chaff when ripe. The first generation[a] of the hybrid inherited a very complex lot of characters. Thus, it inherited both winter and spring character; both the lodging and the nonlodging tendency; both the open and the closed chaff tendency. In this cross the winter character, the nonlodging tendency, and the closed-chaff tendency were dominant. Letting—

W stand for the winter character,
w for absence of winter character (i. e., spring character),
N for nonlodging (i. e., for stiff straw),
n for absence of *N* (i. e., for weak straw),
C for closed chaff, and
c for absence of *C* (i. e., for open chaff),

the formula of the hybrid was *WwNnCc*. Now this hybrid can produce, and does produce, in about equal numbers eight different types of ovules and eight similar types of pollen, namely, *WNC*, *WNc*, *WnC*, *Wnc*, *wNC*, *wNc*, *wnC*, *wnc*. The union of these eight types of ovules and pollen grains gives sixty-four possible, and equally probable, matings. But, as before, some of these matings give identical results; for instance, *WNc* × *WnC* and *WNC* × *Wnc* both give *WWNnCc*. There are, however, twenty-seven different combinations amongst the sixty-four matings; these, together with the number of matings in which each occurs, are shown in Table II.

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[a] Professor Bateson uses the symbol F_1 for first-generation hybrids. The F is the initial letter of the word "filial." Hence this symbol means "first filial generation." Bateson denotes the second and later generations of a hybrid by F_2, F_3, etc. Likewise, he denotes parental generations as follows:

P_1=parents of the hybrid.
P_2=grandparents of the hybrid.
P_3=great-grandparents, etc.

TABLE II.—*The twenty-seven different types in the second generation of a hybrid between a winter wheat, W, with weak straw, n (absence of nonlodging character), and open chaff, c (absence of closed chaff), and a spring wheat, w (absence of winter character), with stiff straw, N (nonlodging), and closed chaff, C.*

Serial No.	Proportions.	Formulæ of the types.	Serial No.	Proportions.	Formulæ of the types.	Serial No.	Proportions.	Formulæ of the types.
1	1	*WWNNCC*	10	2	*WwNNCC*	19	1	*wwNNCC*
2	2	*WWNNCc*	11	4	*WwNNCc*	20	2	*wwNNCc*
3	1	*WWNNcc*	12	2	*WwNNcc*	21	1	*wwNNcc*
4	2	*WWNnCC*	13	4	*WwNnCC*	22	2	*wwNnCC*
5	4	*WWNnCc*	14	8	*WwNnCc*	23	4	*wwNnCc*
6	2	*WWNncc*	15	4	*WwNncc*	24	2	*wwNncc*
7	1	*WWnnCC*	16	2	*WwnnCC*	25	1	*wwnnCC*
8	2	*WWnnCc*	17	4	*WwnnCc*	26	2	*wwnnCc*
9	1	*WWnncc*	18	2	*Wwnncc*	27	1	*wwnncc*
	16			32			16	

16+32+16=64.

Types Nos. 1, 3, 7, 9, 19, 21, 25, and 27 are homozygote, and will all reproduce true to seed. Type No. 1 was the type sought in this cross.

The first nine of these twenty-seven types, constituting one-fourth of the whole generation, are pure winter wheat (*WW*), the next nine (Nos. 10–18), constituting one-half of the generation, are hybrids between winter and spring (*Ww*), while the last nine, constituting one-fourth, are pure spring wheats (*ww*). Each of these three groups of nine types is subdivided in like manner into one-fourth pure nonlodging, one-half hybrid between lodging and nonlodging, and one-fourth pure lodging. Thus, the first three types are all pure winter and pure nonlodging; these three types constitute 4 sixty-fourths of the generation, or one-fourth of the first group of nine. The second group of three are all pure winter, but hybrid with reference to the lodging character: these three constitute 8 sixty-fourths of the generation, or one-half of the first group of nine, etc. Thus, each of the three groups based on the winter-spring character pair is subdivided into three groups based on the straw character, thus giving nine groups based on these two character pairs. Each of these nine is similarly divided into three types, based on chaff character. This gives in all twenty-seven different combinations. Of these twenty-seven combinations, eight are seen to be homozygote with reference to all three character pairs. This means that these eight are pure bred as far as these characters are concerned and will show these characters in all their progeny. The other nineteen types are heterozygote, or cross-bred, with reference to one or more of the character pairs, and will thus not reproduce true to seed.

The one combination which was sought in this cross is type No. 1 of Table II. This type constituted only 1 sixty-fourth of the second generation of this hybrid. It is the combination *WWNNCC*, which is pure winter wheat, nonlodging, with tightly closed chaff. The most undesirable type, *wwnncc*, also occurred once in sixty-four times—that is, it was a spring wheat which lodged and had weak chaff. Further mention of this new type of wheat will be made later in discussing the application of the principles to plant breeding.

We may now state the law of recombination as follows: In the second generation of a hybrid there tends to occur every possible combination of the original parent characters.[a]

We may further add to this law that every one of these combinations will, if the second generation is numerous enough, occur in some individuals in homozygote form, and will thus be firmly fixed and reproduce true to seed.

Although all the possible combinations will occur in the second generation of a hybrid (that is, provided the second generation is numerous enough to permit them to occur) unfortunately most of them will be mixed with other combinations that have the same external appearance but very different hereditary tendencies. This is due to the fact of dominance. For instance, the homozygote form *WWNNCC* of Table II can not be told by inspection from the form just following it (*WWNNCc*) or from several other of the twenty-seven combinations. One way to overcome this difficulty in a self-pollinated species is to save the seed of each second-generation plant separately. If the species is one that is not self-fertilized, but one which can be artificially self-fertilized, we can accomplish the segregation of the desired type by artificial self-fertilization of all the second-generation individuals that appear to be of the type desired and by planting their seed separately. When the next generation matures it will be seen which of them have reproduced true to type. The seed of these may be saved, and thus form the basis of a new and fixed variety in self-fertilized species and in such open-fertilized species as will endure such self-fertilization.

A very beautiful illustration of the law of recombination is seen in the work of Professors Price and Drinkard, of the Virginia Agricultural Experiment Station, in their experiments with hybrid tomatoes. Two varieties were crossed which differed in three respects, namely, one variety had green leaves, the other yellowish green; one had red fruit, the other yellow; one had pear-shaped fruit, the other round.

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[a] The writer discovered this law independently in 1901. See Bulletin No. 115, Office of Experiment Stations, U. S. Dept. of Agriculture.

In the second generation of this hybrid every one of the eight possible combinations of these three pairs of characters was found, as follows:

Serial No.	Leaf color.	Fruit color.	Fruit shape.
1	Green	Yellow	Round.
2	Green	Yellow	Pear-shaped.
3	Green	Red	Round.
4	Green	Red	Pear-shaped.
5	Yellowish	Yellow	Round.
6	Yellowish	Yellow	Pear-shaped.
7	Yellowish	Red	Round.
8	Yellowish	Red	Pear-shaped.

Two of these eight types were like the original parent varieties, the other six were new. This case illustrates well the power a knowledge of the law of recombination puts into the hand of the breeder. Breeders have unconsciously used this law since breeding first became an art, but a knowledge of the principles involved now enables them to accomplish desired results much more quickly and surely than was formerly the case.

FLUCTUATING VARIATIONS.

From what has been said concerning the law of recombination it is easy to see that in a species which naturally cross-fertilizes in the field we are continually getting new combinations of hereditary characters. For instance, in a cornfield hardly any two plants can be found that carry exactly the same combination of hereditary characters. If we should take a single grain of corn and plant it where it can not cross-fertilize with another its progeny would break up into types somewhat as shown in Table II, except that, instead of stopping with twenty-seven different types, each of these would be subdivided into three others, and each of these again subdivided in the same way, and so on within the limits of the number of separate and independent hereditary characters for which the grain we started with was heterozygote. Generally speaking, only a comparatively few of these characters will be important to the breeder, so that the others may be neglected. But we must not overlook the fact that in the main the remarkable fluctuations of characters seen in a cornfield are due to this recombination of characters from year to year. On the other hand, if we take a single grain of wheat and plant it, then save every seed of it for planting, the plants produced in the second generation would, ordinarily, be exactly alike in so far as their combinations of hereditary characters are concerned. This is because under ordinary field conditions wheat is self-fertilized, and a field of wheat in the main consists of plants that are completely homozygote with reference to every one of their hereditary characters. When we do get a plant which is completely homozygote in all its characters, then it will transmit the same form of every character to all its offspring, and we have eliminated all variations due to recombination of characters. There will still be differences between the plants grown from the same seed, but these differences will be due to environmental influences, such as differences in available moisture, plant food, sunlight, and the like. It is highly important to make this distinction between individual variations which are due wholly to environment and those which are due to recombinations of hereditary characters. It will be seen later that so far as experimental evidence goes there is much reason to believe that selection of those fluctuations which are due wholly to environment as a rule has no effect whatever in changing the hereditary characters of the plant. On the other hand, in those plants which are not homozygote in all their characters, as is practically always the case in a species that regularly cross-fertilizes, there will be variations due to recombinations of different characters, and selection will have a marked effect in species of this kind. The effect of selection on fluctuating variations has been much confused because of the effect produced by mass selection in mixed populations of fixed forms like wheat, which effect will be further discussed later. In wheat, and other self-fertilized species, individual selection—that is, selection in which we keep the progeny of each mother plant separate—soon proves that we can not modify these fixed strains by selection; that is, generally speaking. The facts have further been confused because of the effect which either mass or individual selection has in gradually changing the character of cross-fertilized crops like corn. In these cross-fertilized crops either mass selection or selection annually to a single mother plant causes a gradual change in the direction of the selection. But when we eliminate the effect of the law of recombination, which occurs continually in cross-fertilized forms, and practice selection annually to a single mother plant, we find that it is apparently impossible to produce modification by selection, except in rare instances. The investigations on which this reasoning is based will be given later in these pages.

The amount of investigation which this subject has received can hardly be said to be sufficient to settle it for all cases, for there are a few exceptional cases which do not behave in the usual way and which are not understood. In the main, however, the investigations all agree. The first work bearing strictly on the effect of selection on forms from which all variation other than fluctuating variation due to environment has been eliminated was done by Prof. W. Johannsen, of Copenhagen, on beans and barley. This work will be referred to more in detail when we come to consider the effect of selection on self-fertilized species, as will also the remarkably accurate work of Doctor Nilsson, whose work at Svalöf, Sweden, is so well known through the writings of De Vries. Some of the work on vegetatively propagated species will be given in dealing with the effect of selection on this class of plants.

RUNNING OUT OF VARIETIES.

It is quite generally believed that there is a tendency for vegetatively propagated varieties to "run out." This subject has received much discussion but very little careful investigation. There is no question that in many species such varieties do lose vigor and become practically worthless after a few years. Carnation growers all agree that varieties of these plants are short lived. Varieties of carnations seldom retain their vigor a dozen years. It is generally believed that varieties of potatoes retain full vigor only for a few decades. With no selection this is undoubtedly true. We do not know just what effect careful selection to maintain yield might have on the length of life of a variety of potatoes. It is certain, however, that the old Peachblow potato, so popular half a century ago, has been maintained in full vigor by selection to the present time. Mr. E. H. Grubb, of Colorado, one of the leading potato growers of that State, is now growing this variety and finds it an excellent yielder. It is probable, however, that potato varieties do tend to run out. The same may be said of apples, but, as in the case of potatoes, definite investigations on this point are lacking.

On the other hand, there are species that have completely lost the power of producing seed, as, for example, the banana. These have been propagated vegetatively for ages without loss of vigor. But we can not say that the same variety persists indefinitely, because the facts are wanting. It is probable that among vegetatively propagated races we may find every gradation between races which run out very quickly and those which remain vigorous indefinitely.

A good many species of plants produce seeds parthenogenetically,[a] as the dandelion, certain species of Hieraceum, etc. These are among our most vigorous weeds. How long they have propagated asexually we do not know. They may, however, be cited as instances of plants which apparently retain their vigor through long periods without recourse to sexual propagation.

What has been said of races propagated vegetatively applies equally to those which are habitually self-fertilized, with perhaps the difference that in most such species there may occasionally occur cases of cross-fertilization. It is quite generally assumed that self-fertilized races tend to run out. There is some evidence that such is the case. This is especially true of varieties of wheat. A single variety seldom retains its supremacy in any given locality for half a century. Yet it is far from demonstrated that careful selection of wheat varieties would not maintain vigor almost indefinitely. This whole question of the running out of varieties needs much further study before the last word can be said on the subject.

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[a] That is, without fertilization. In these plants the reduction division is omitted in those mother cells which develop into seeds.

Having outlined the main principles with which we have to deal in plant breeding, we may now proceed to a consideration of the different methods of breeding and selection and the application of the principles involved.

SELECTION WITHOUT ARTIFICIAL CROSSING.

We have already seen that close-fertilized and cross-fertilized species behave differently under selection. In addition to self-fertilized and cross-fertilized species we must also consider the effect of selection on those varieties which are propagated vegetatively; that is, from cuttings, grafts, tubers, etc., including all methods of propagation other than from seed.

VEGETATIVE PROPAGATION.

In plants propagated vegetatively we have several kinds of variation to consider, for the effect of selection on each of these is different. First, we have those fluctuating variations which are due wholly to environment, such as difference of food supply, moisture conditions, etc., which modify the individuals of a generation but which are not hereditary. As we have already seen, such investigations as have been made on this subject indicate that in nearly all cases of fluctuating variation due to environment selection is entirely without permanent effect in changing the plant from year to year. In Bulletin No. 127 of the Illinois Agricultural Experiment Station Dr. E. M. East made a careful survey of all the literature he could find relating to the effect of selection on these fluctuating variations in potatoes. He concluded that it is not proved that selection can change these variations, though the question is left in some doubt.

Prof. H. S. Jennings, of Johns Hopkins University, has during the past few years made some investigations on the unicellular animal Paramecium which must rank among the most important biological work that has been done, at least in the field of experimental evolution. While Paramecium is an animal, it propagates for hundreds of generations by simple division, and hence there is every reason to suppose that the principles applicable to Paramecium are applicable to plants which are propagated vegetatively. Jennings gives an excellent summary of his work in the American Naturalist for June, 1909, where reference will be found to the original technical publications. First, he studied abnormal individuals to see whether or not their abnormalities were inherited. In many of his cultures individuals could be found that had various peculiarities. Although he sought patiently for some peculiarity of this kind that might be inherited and although he found many such peculiarities, in no case did he find one that is inherited in the proper sense of the word. The peculiarities in question never appeared in both of the individuals resulting from a division. Thus there was no tendency for them to multiply and spread over the race. Concluding his discussion of such cases, Jennings remarks: "Examination of a large number of cases in Paramecium shows that these untypical characters are never reproduced in the young."

Jennings also found that the descendants of a single individual varied greatly in size. This suggested the idea that by selecting continually from the largest and the smallest, two races could be developed which would differ in size, although descended from the same original individual. This experiment was carried on for a very long series of generations, one line consisting of the largest individuals that could be found and of their largest progeny, the other of the smallest individuals and their smallest progeny. At the end of the experiment the two lines were brought under the same environmental conditions and within a very short time the average length of the two types became identical. This led Professor Jennings to remark that "Selection within a pure race is of no effect on size," and again, "Neither selection nor environmental action changes the size of the pure race."

This investigator found eight distinct types of Paramecium in a group which was previously supposed to consist of two species differing in size. Figure 1 illustrates the relative sizes of the individuals in these eight races. It is seen that even the extreme forms overlap, and it was found that if the smallest individual of the largest race be selected and its progeny grown with continual selection from the smallest individuals to be found, no matter how long such selection was continued the progeny of this small individual would soon cover the whole gamut of variation of the race to which it belonged, and the same was true for each of the other races. Speaking of the effect of selection on such a species, Jennings says:

> How will selection act on such a complex species? As we have seen, selection within a single race is without effect. But if we make selections among the individuals of a mixed collection of races, such as figure 1 shows, we reach most instructive results. By making our selections in the proper way, we for a time make steady progress toward a certain goal. We will suppose that we do not know of the existence of these races; this is the case with most experiments in selection. From the species as a whole, as shown in figure 1, we will select for increased size. Let us follow the old plan of selecting many individuals showing the desired character; we will preserve all specimens above the mean size of the entire collection; that is, we divide the

collection at $x—x$, rejecting all those to the right. By so doing it is evident that we exclude all specimens of the two smallest races c and i, while preserving the majority of the specimens of the larger races. Allowing these to propagate, we of course get a mixture of the remaining larger races. Hence the mean size of the whole collection will be greater than at first. Selecting again those above the mean size of this lot, we drop out another small race, and the mean of the collection as a whole again rises a little. We are making good progress in the improvement of our species. By taking successive steps of this character, dropping out the smaller races, first partly, then completely, one after another, we can for a long time continue to improve by selection, but finally we reach a stage in which all but the largest race have been excluded. Thereafter we can make no further progress. In vain we choose for breeding the largest specimens of the lot; all belong to the same race, so that all produce the same progeny. Selection has come to the end of its action. * * *

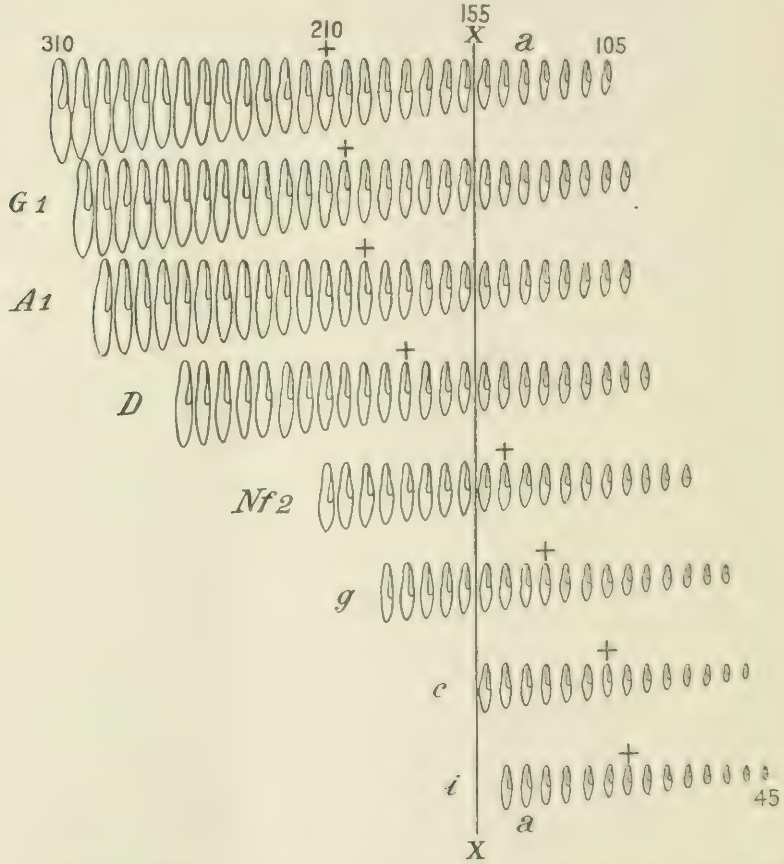

Fig. 1.—Graphic illustration of the range of fluctuations of each of the eight pure races of Paramecium studied by Jennings. (Reproduced from the American Naturalist.)

Selection here consists simply in isolating already existing races. It produces nothing new. * * *

Systematic and continued selection is without effect in a pure race, and in a mixture of races its effect consists in isolating the existing races, not in producing anything new.

Similar work with identically the same result has been done on hydra by Elise Hanel[a] and by M. A. Barber[a] on yeasts and bacteria. In Barber's work there were some exceptional cases which will be mentioned later. He found many races of each, but each race was constant, with the exceptions noted below. Long-continued selection had no effect in changing one of these races. Barber also studied individuals having various peculiarities. While the vast majority of these peculiarities behaved exactly as Jennings found them to do in Paramecium, he did find a few cases within a pure race (that is, in the descendants of a single individual) that transmitted their peculiarities to their descendants. Here we have actual evolutionary change in a race. Races of yeast were produced having cells of different form from the parent type and races of bacteria composed of longer rods than the parents, but such cases were extremely rare. Thus we must assume that there are occasionally permanent evolutionary changes. As to the amount of change in such cases we can get some information from Jennings's races of Paramecium, assuming, of course, that the differences between the various races have come about by evolutionary change. The difference between the average size of the two smallest races of Paramecium studied by Jennings was only 0.00028 inch, yet the progeny of any individual, large or small, in either of these two races, accurately maintained this difference between the races. The important point in all this is that when we are dealing with individuals of a pure race, or, as Webber calls them, a "clonal" race of variety—that is, individuals descended from a single individual by vegetative propagation—except for those very rare cases in which positive evolutionary change occurs the fluctuating differences between individuals have absolutely no bearing on the evolutionary process. According to Jennings there seems little doubt that this is true for organisms in general. He says:

> In Paramecium, in the extensive study of many races for hundreds of generations by exact statistical and experimental methods, not one single instance was observed of variation in the sense of an actual change in the race.
>
> So far as the evidence goes every race is essentially the same throughout the work and may have been the same for unnumbered ages.

Jennings emphasizes the fact that real evolutionary changes do not occur often or easily. "The fundamental constitution of the race is resistant to all sorts of influences. It changes only in excessively rare instances and for unknown causes."

In summarizing his conclusions, Jennings makes the following statement: "Until some one can show that selection is effective within pure lines it is only a statement of fact to say that all the experimental evidence we have is against this."

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[a] Cited by Jennings in American Naturalist, June, 1909.

The following statement is made by Dr. Raymond Pearl and Mr. Frank M. Surface in Bulletin No. 166 of the Maine Agricultural Experiment Station:

> There is a rapidly accumulating mass of evidence that the chief, if not the entire, function of selection in breeding is to isolate pure strains from a mixed population. It is found in actual experience impossible to bring about by selection improvement beyond the point already existing in the pure (isolated) strain at the beginning.

These writers do not here distinguish between the effect of selection in self-fertilized and cross-fertilized species, but what is said does apply to close-fertilized species strictly, where hybridizing is not practiced, and with certain limitations it also applies to cross-fertilized species, as will be seen later.

If the conclusion that selection of fluctuating variations is without effect is correct, then it follows that after we have by trial found the best individuals in a crop propagated vegetatively we have gone as far as selection enables us to go, except as immediately stated below.

But there is a second type of variation in vegetatively propagated crops which can be affected by selection. Each individual plant is endowed with a certain number of hereditary characters. These characters may or may not come to complete development under given environmental conditions, or some of them may reach complete development while others may fail to do so. In so far as this failure to develop is due solely to environmental conditions selection is without power to modify the crop. But it would appear that from time to time, or perhaps more or less continuously, changes are going on with reference to these hereditary characters by which their tendency to develop under given conditions changes; so that in a crop like potatoes we may in time get a good many varieties from the descendants of a single individual. But these varieties, in the main, arise by certain hereditary characters becoming latent or possibly in some cases disappearing altogether. Again, it may be that the tuber with which we start a race may have a good many latent characters in it whose tendency to develop may subsequently increase, so that occasionally we get a variety which differs from that with which we started by the development of certain characters which were not patent in our original stock. For instance, a white variety may produce tubers with colored skin. Color is especially likely in white varieties to occur in the vicinity of the eyes of the tuber.

The more usual variation which occurs in such cases is for characters that are present to become latent, so that we are more likely to get light color or white from colored stock.

What has been said about variation in vegetatively propagated plants applies also to bud variations, or the so-called "bud sports."

In nearly all cases these sports differ from the plant on which they originated by lack of characters that are visible in the mother plant. Occasionally, however, the reverse is true. But when a new character appears in a bud sport it is in nearly all cases a character common to the species, which was presumably latent in the mother plant.

The Ethel Maule dahlia furnishes what appears to be an example. This is sold as pure white. Mr. W. A. Andrews, of Washington, D. C., has grown this dahlia for four years. Last year (1908) one of the plants produced flowers having a decided pink tinge, especially in the center of the flowers. This year he has several of the plants produced (by division) from the pink-flowered one of last year, and all of them show the pink color. All the plants of this variety in Mr. Andrews's garden have been propagated by division from a single plant obtained four years ago. Presumably the pink color is latent in the original stock and has been partially revived in these pink-flowered individuals.

In those vegetatively propagated plants where variation occurs by hereditary characters becoming latent—and this type of variation seems to be quite common, especially in potatoes—selection of seed is of great importance. In this case selection enables the breeder to keep his stock up to standard, at least much longer than would be the case without selection, and where variation occurs by the development of characters which were previously latent it enables him to preserve such variations when they are of value.

The results of the application of the principles here stated to the selection of seed potatoes have been in some cases quite marked. For instance, a potato grower in Michigan some years ago began the practice of digging by hand enough potatoes for seed and saving only those hills that had six or more merchantable tubers and no small tubers. When he first began this practice he found only sixteen hills out of each hundred dug that came up to his standard, but after he had continued the practice for five years the number of such hills had risen to seventy in a hundred. Under the direction of Mr. L. G. Dodge, of the Office of Farm Management, several New England potato growers have been applying these principles for two years past. The first year there was an average of about eight hills per hundred that came up to standard. The second year from seventeen to twenty hills met the conditions. This is as far as the experiment has proceeded at the present time. Some work done on potatoes by Mr. C. W. Waid, of the Ohio Agricultural Experiment Station, has given similar results. In this work, starting with the same original lot of tubers, three strains were grown, as follows: (1) Seed from high-yielding hills, (2) seed from low-yielding hills, and (3) unselected seed. Taking the yield of the unselected seed as a basis, the results were as follows:

Source of seed.	1904.	1905.	1906.	1907.[a]	1908.[b]
From high-yielding hills	122	127	147	125	171
From unselected hills	100	100	100	100	100
From low-yielding hills	70	55	77	66	91

[a] See Report, American Breeders' Association, vol. 3, p. 191 et seq.
[b] See Circular No. 90, Ohio Agricultural Experiment Station.

SELF-FERTILIZED SPECIES.

The effect of selection on self-fertilized species, such as wheat, barley, and oats, is essentially the same as it is on species propagated vegetatively. Doctor Nilsson in his remarkable work at Svalöf, Sweden, has many times taken an unselected lot of seed from some cultivated variety of wheat or oats and planted each seed individually to study the character of the plants produced. He rarely finds two plants exactly alike. But when he saves the seeds from these plants separately the next year the progeny of each plant is, as a rule, found to be so much like the parent plant as to be indistinguishable from it except for such fluctuations as may be due to environmental influences only.

Occasionally in work of this kind a plant is found which is not homozygote in all its characters. In other words, it is not absolutely pure bred. These plants split up in the next generation according to the law of recombination. Furthermore, their presence indicates that there is occasionally cross-fertilization in wheat and oats, so that ultimately in a wheat field there may be found practically every possible combination of all the characters present in the field, and in time every one of these combinations will come to exist in some individuals in homozygote form; for, as will be seen later, a self-fertilized plant tends to split up into all the fixed forms which can be made from the various combinations of the characters present in it.

Neglecting for the present the occasional cross-fertilizations in a field of wheat or oats and the resulting heterozygote plants that are produced in this manner, which will be considered under the next heading, selection without cross-fertilization in self-fertilized species can have no effect except to enable the breeder to find those individuals which are best among the population with which he is dealing. After he has found these individuals he can not improve them by selection. On the other hand, he may be able to hold them up to a high standard by means of selection, for presumably, as in the case of potatoes, the hereditary characters present in wheat may change in their tendency to develop. Especially may characters that are present get into the habit of failing to develop and thus give rise to inferior plants in the progeny of what was originally a high-class individual.

While experimental evidence for the above statements is not as plentiful as it ought to be, Doctor Nilsson has done so much work along this line that the propositions enunciated may be considered practically established. Professor Johannsen, of Copenhagen, has done a great deal of work of the same kind with exactly the same results. At the 1906 Genetic Conference in London he said, "In a population containing only one single type the selection of fluctuations has no action at all." Johannsen has several races of beans which he has grown pure for several years and which are fully homozygote. He has fully tested the effect of selection on certain seed characters of these beans. Speaking of the results,[a] he says, "Selection for weight, for absolute length, or relative breadth has had absolutely no observable influence on these characters." Johannsen has obtained similar results with barley.

After what we have seen to be true in vegetatively propagated races it should not be surprising that similar results occur in self-fertilized races, for although such races go through the form of recombining the characters when they produce seed, the two members of each pair of characters being exactly alike, we get no new combinations, so that reproduction by seed in completely homozygous strains differs little, if at all, in its results from vegetative propagation.

The fact that in a field of a self-fertilized crop a very large majority of the plants are perfectly fixed in their hereditary characters and will reproduce themselves with almost absolute fidelity from seed has led a good many biologists to consider every one of these plants which differs from its neighbors in any way to be what they call "elementary species." They overlook the fact that these forms are fixed simply because they are homozygote in all their characters and would behave in exactly the same manner whether the evolutionary changes that produced them are either very slow and gradual or occur suddenly at long intervals.

The problem, then, in selecting self-fertilized plants is to find the best individuals and propagate from them. There are two ways of selecting such plants, which give somewhat different results. One of these we may term "mass selection," the other "individual selection."

MASS SELECTION.

Mass selection is that form of selection in which a number of superior plants or parts of plants are chosen but their seed is not kept separate. It may happen that some of the selections thus made are superior because they have been grown under very favorable environment and that another year when the environment is less favorable they may prove to be very inferior. Others may prove to be superior under a wider range of environmental conditions, so that from year to year they will be superior. The next year mass selection would be mostly from those plants which are what we may call permanently superior, together with a few of those which merely happen to be superior under the given conditions. The continuation of mass selection thus tends to improve from year to year the general character of the crop, but it does this by the gradual elimination of the progeny of those plants which are not superior except under very favorable conditions. This gradual improvement that occurs in mass selection has misled biologists and plant breeders generally into believing that selection could affect fluctuating variation.

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[a] Zeitschrift für Induktive Abstammungs- und Vererbungslehre. September, 1908, p. 2.

The effect of mass selection of self-fertilized crops is well illustrated by some of Prof. C. A. Zavitz's work at Guelph, Ontario, Canada. In his annual report for 1905 he gives the results of sixteen years' continuous mass selection on oats and barley. These are given below. For convenience, his results obtained by similar methods with potatoes are also given here. It will be noticed that mass selection has the same effect in self-fertilized wheat and oats as in potatoes, which are propagated vegetatively.

Table III.—*Average yields by four-year periods, in bushels per acre, of oats, barley, and potatoes, showing the effect of mass selection on self-fertilized and on vegetatively propagated crops.*

Crops.	1890-1893.	1894-1897.	1898-1901.	1902-1905.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Oats, average for 8 varieties	74	79	83	100
Barley, average for 8 varieties	50	54	63	63
Potatoes, average for 7 varieties	120	216	218	249

The very marked effect in the case of potatoes is probably due to degeneration which had occurred in many vegetative strains before the selection began, the progeny of these degenerate strains being gradually eliminated by mass selection.

The Mandscheuri barley, now so largely grown in Ontario, is descended from a single pound of seed obtained from Prussia in 1889. Of this variety 567,000 acres were grown in Ontario in 1908. Since the introduction of Mandscheuri, the barley crop of Ontario has increased in value from $4,800,000 to $12,900,000, and this is in part due to the larger yielding power of this variety. The greater profit due to larger yields has caused an increase in acreage.

INDIVIDUAL SELECTION.

In the form known as individual selection we start with superior plants and keep their seeds separate. This enables us very quickly to determine which of the original selections are superior under a wide range of conditions, so that within a few years we can determine which of our original selections represent the best strains in the variety. Then by propagating from them and by continuously selecting to avoid saving any plants which may be deteriorating from hereditary characters becoming latent, we can maintain the variety at a high standard. But it must be remembered that we can not increase the superiority of a pure strain by selection except in those comparatively rare cases where characters that were latent in our original selection change in their tendency to develop and happen to increase the superiority of the strain.

That latent characters may reappear in a variety is shown by the following facts. Sometimes, in varieties of potatoes having white skin, tubers are found which have purplish or red skin, at least over part of the surface, and especially about the eyes. Bud sports sometimes exhibit characters not apparent in the parent stock, but common to other varieties of the species. In Doctor Nilsson's work at Svalöf, Sweden, black or yellow oats occur at wide intervals in white varieties. All these facts indicate that latent characters occasionally become patent.

We have already referred to the effect of mass selection on barley at the Ontario Agricultural Experiment Station. Professor Zavitz has also used individual selection on varieties of this crop. In 1903 he selected 9,972 grains of the Mandscheuri barley and planted them individually. Seed of 33 of these were planted separately in 1904. By 1908 all but three of these strains had been discarded. One of these, known as "O. A. C. No. 21," which outyields the original variety, is now rapidly replacing the latter on Ontario farms.

The selection at the Minnesota station, begun by Prof. Willet M. Hays, is individual selection. The seed of each plant, to serve as the original parent of a strain, is saved separately, so that the yielding power of pure strains is determined by several years' test of successive generations of their self-pollinating progeny. The best of these are finally brought into culture. This method enables the breeder to secure the best strains present in the seed with which he starts, or, as Professor Hays puts it, it enables the breeder to find those plants having the highest "centgener" power; that is, the power of producing strains with maximum yields under the widest range of environmental conditions. Some of the wheats obtained in this manner at the Minnesota station have proved decidedly superior to the original mixed stock from which they were isolated.

In these homozygote forms, which constitute the major part of a field of any crop which habitually self-fertilizes, there is little, if any, more variation than in plants which are propagated vegetatively.

CROSS-FERTILIZED SPECIES.

The effect of individual selection on cross-fertilized species, such as corn, is very different from what it is in self-fertilized species. Here the plants chosen are more or less cross-fertilized with other plants and the seeds obtained from a single plant are not all alike in content of hereditary characters. Hence we may get distinct differences in the individuals grown from this seed. Either mass selection or individual selection in a crop of this character may make decided changes in it for the reason that, in the seed of every plant, combinations of hereditary characters will occur that are unlike those in the original plants selected. Some of these may be superior to the original plants. For instance, the plant with which we start may be heterozygote with reference to a particular character which we will call "*A*." That is, it inherited from one of its parents the presence of this character and from the other its absence. Its formula with reference to this character would therefore be *Aa*. Such a plant will produce progeny one-fourth of which has the formula *AA*, one-half *Aa*, and one-fourth *aa*. Now, the combination *AA* may be superior to *Aa* and *aa*, so that in the seed of our selection we may get something better than the plant selected. On the other hand, we may also get something not so good. Selection alone, therefore, enables us to make positive improvements in crops which regularly cross-fertilize.

The work done on the corn plant at the Illinois Agricultural Experiment Station is perhaps the best illustration of the effect of selection on crops that cross-fertilize. Bulletin 128 of that station gives the results of ten years' selection of corn for high and low oil content and for high and low protein content. Some of these results are given in Table IV.

TABLE IV.—*Effect of selection in a cross-fertilized species. The figures of column 2 give differences in percentage content of oil between two strains of corn of similar origin, one selected for high and one for low oil content. Column 3 gives similar differences between two other strains selected, one for high and the other for low protein content.*

Years.	Oil differences.	Protein differences.
	Per cent.	*Per cent.*
1896	0.00	0.00
1897	.67	.55
1898	1.16	.50
1899	1.82	1.60
1900	2.55	2.98
1901	2.66	4.08
1902	3.39	4.12
1903	3.53	4.52
1904	4.08	5.76
1905	4.71	6.15
1906	4.71	5.62

Bulletin 132 of the same station gives the results of six years' selection of corn for high and low ears. See Table V.

TABLE V.—*Difference between two strains of corn selected for ears high or low on stalk.*

Years.	Difference in height of ears.	Difference in number of internodes in stalks.
	Inches.	*Number.*
1903	13.6	1.5
1904	12.0	1.5
1905	21.7	1.8
1906	31.1	4.1
1907	39.2	3.3
1908	34.2	4.0

Another instance of the effect produced on a species which is partially cross-fertilized is seen in some interesting work of Professor von Rümker at the Breslau Experiment Station in Germany. This work was done on rye, in which species more or less cross-fertilization occurs. By continued individual selection for color of seed Professor von Rümker finally obtained several strains of markedly different color. Yellow color was more difficult to fix than green. This is probably due to the compound nature of the yellow color from the Mendelian standpoint. Some interesting cases of correlation were found in this work. Green-colored seeds produced stronger stalks; brown seeds were less winter hardy. It was found that the selection must be continued in order to maintain the characters for which the selections were made. It is doubtful if these results could have been obtained in a strictly self-fertilized species.

The reason why selection produces these effects on cross-fertilized plants is seen in the following: Suppose we start with a corn plant that is heterozygote for yellow and white corn and for starchy and sweet corn characters. The presence of yellow may be represented by Y, the absence of yellow (that is, white) by y; the presence of starch-forming character by S, and its absence (that is, sweet-corn character) by s. Figure 2 shows the nine different types of corn which would be produced by the individuals. If, now, we plant all the seed produced by these nine types of corn and plant them where they can freely cross-fertilize, but where they will not cross with other kinds of corn, the next year we shall again get these same nine types in approximately the same proportion, and so on indefinitely. This is shown graphically in figure 2, which shows what happens when we have a mixture of types that cross-fertilize with each other. This figure will be understood when it is explained that the space between any two adjacent horizontal lines represents the proportion of the population of the type represented by the formula in that space. Here each of the nine spaces maintains the same width from generation to generation. This means that each of the nine types present tends to remain in the same proportion from generation to generation under these conditions.

Referring again to figure 2, and supposing that we desire to select from this mixed population and perpetuate the type *YYSS*—that is, pure yellow starch-forming corn—we would at once discard the following forms: *YYss*, *Yyss*, *yySS*, *yySs*, and *yyss*. All of these would either be white or of the sweet type, or both. Discarding all these types that are not yellow starch-forming types, we would still have left the second, fourth, and fifth types shown in figure 2, all of which would be yellow and would have starchy grains, because the presence of these two characters is dominant over their absence, and these types heterozygote for one or both of these characters can not be distinguished by inspection from type 1, which is the type we wish to perpetuate.

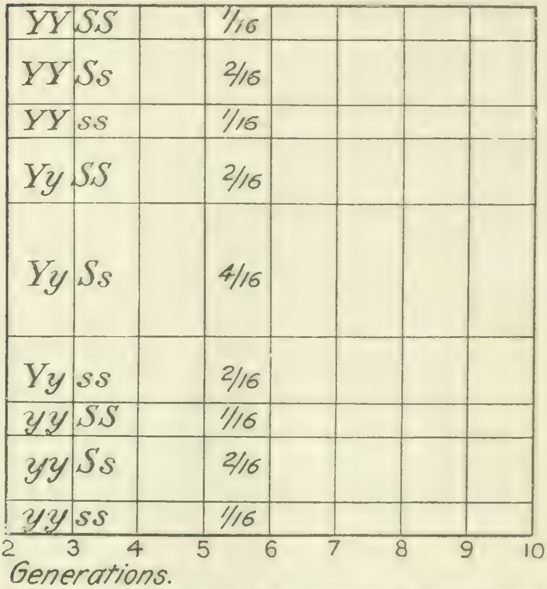

FIG. 2.—Graphic illustration of ten generations of corn with no selection, the first generation of which is *YySs*. The proportion of each type is indicated by the vertical space between the horizontal lines above and below the type symbols. Thus, *YYSS* is one-sixteenth of the whole population. Under the conditions mentioned each type tends to remain in the same proportion from year to year.

Selecting for seed those plants which do have yellow, starchy grains—that is, types 1, 2, 4, and 5 of figure 2—and planting them where they can cross with each other but not with other corn, the next year the proportion of each of the nine types that would appear would be as shown in Table VI, column 3. If we make the same kind of selection again the next year the proportions of the nine types would be as in column 4. Table VI shows the results that would be obtained at the end of the sixth generation by this kind of selection in a cross-fertilized crop.

TABLE VI.—*Types and their percentages in the descendants of YySs for several generations with cross-fertilization and continued selection to type YYSS. Regarding YySs as the first generation, we have:*

Types.	Generations.				
	2.	3.	4.	5.	6.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
YYSS	6.25	19.8	31.6	41.0	48.2
YYSs	12.50	19.8	21.1	20.5	19.3
YYss	6.25	4.9	3.5	2.6	1.9
YySS	12.50	19.8	21.1	20.5	19.3
YySs	25.00	19.8	14.0	10.2	7.7
Yyss	12.50	4.9	2.3	1.3	0.8
yySS	6.25	4.9	3.5	2.6	1.9
yySs	12.50	4.9	2.3	1.3	0.8
yyss	6.25	1.2	0.4	0.2	0.1

The type *YYSS* gradually increases until in the sixth generation it constitutes 48 per cent of the crop. This type, together with types *YYSs*, *YySS*, and *YySs*, all of which appear to be the same as *YYSS*, constitutes 94.5 per cent of the sixth generation. Thus in cross-fertilized crops mass selection to a given type gradually establishes that type, not so rapidly, however, as it does in self-fertilized species, after hybridization.

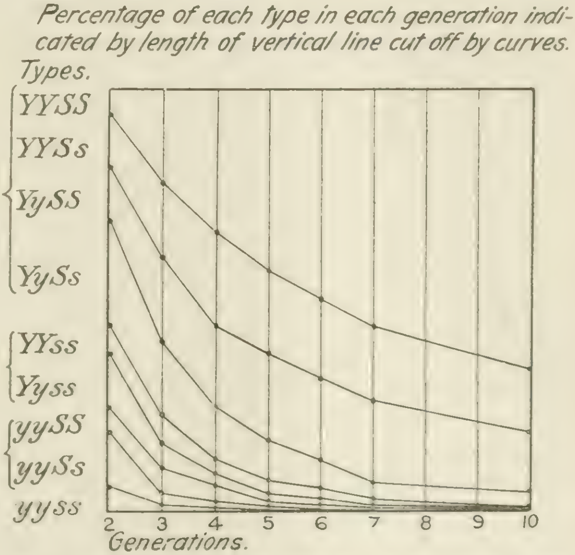

FIG. 3.—Graphic illustration of the effect of mass selection in cross-fertilized species. Selection for type *YYSS;* types so arranged as to bring together those that resemble each other. The proportion of type *YYSS* from generation to generation is shown by the space between the top horizontal line and the upper curved line. It would seem to increase from generation to generation. The proportion of type *YYSs* from generation to generation is indicated by the vertical width of the space between the two upper curved lines. Similarly, the space beginning opposite each type formula indicates the proportion of that type present from generation to generation.

Figure 3 shows the same thing graphically for ten generations. In this figure the space between the top curved line and the horizontal line at the top of the diagram shows the proportion of the type *YYSS* present from generation to generation. It is seen that in the second generation only a small proportion (one-sixteenth) of type *YYSS* is present. In generation six, almost exactly half the population is *YYSS*, while in generation ten this type constitutes about 65 per cent of the whole. The proportion of type *YYSs* present from generation to generation is indicated by the space between the two upper curved lines. It is seen that this type increases slightly until the fourth generation, after which it gradually decreases. The five types at the bottom of the figure decrease very rapidly from the second generation on, so that by the tenth generation they have almost disappeared, and the population is made up almost entirely of yellow, starch-producing types which are either pure (type YYSS) or heterozygote (types YYSs, YySS, and YySs) for one or both of the characters with which we are dealing. Table VI and figure 3 thus illustrate the effect of mass selection on crops which cross-fertilize, and this effect is seen to be a gradual approach toward the type selected.

Evidently the limit of the effect of selection in a case of this kind is reached when practically the whole crop is homozygote for the character selected. No further advance can be made by selection, and it must be remembered that in order to hold the crop at this high degree of excellence selection must be continued, because here and there plants will vary by certain characters becoming latent and thus reducing the general average of superiority in the strain.

The problem of improving cross-fertilized species or varieties by selection to a particular type is complicated by the fact that in plants which ordinarily cross-fertilize we are apt to lose vigor when we get our plants too much alike. That is, these plants have been used to cross-breeding, and when we get our population very uniform, which is only another way of saying get them very close kin to each other, the yield is liable to run down because of this very uniformity. There is some question, therefore, whether in a cross-fertilized crop we should attempt to get great uniformity.

We can partially overcome this difficulty by each year selecting the best individuals we can find and planting them in alternate rows so as to get as much cross-fertilization as possible. In corn the ear-row method of breeding permits this to be done. The methods adopted by some of the best corn breeders in the country at the present time are essentially as follows: Every year they go through the seed plot and also through the cornfield and select the best ears they can find to use in the seed plot the next year. As many ears are selected as there will be rows in the seed plot. In this way there will be the normal cross-fertilization in the seed plot with the resulting vigor that comes from cross-fertilization. Careful account is kept of the yield of each of the rows in the seed plot, so that the breeder may learn what ears selected the year before tend to produce the best yields. This enables him the next year when he goes to the seed plot or the cornfield to select seed to know what types to look for, and it is probably wise, from the standpoint of yield, to select each year two or three types, if not more, provided they all yield well, so as to insure as much cross-fertilization as possible in the seed plot.

The fact is, we know very little indeed about the relation between yield of corn and type of ear. Prof. A. E. Grantham, of the Delaware Agricultural Experiment Station, recently called the writer's attention to the fact that in communities that have been unaffected by modern ideas about corn breeding, the best ears of corn are usually of the so-called "slick" type. He suggests that this may be a case of the survival of the fittest. Farmers have from year to year selected sound ears for seed, paying little or no attention to type. The prevalence of slick ears may therefore represent a case of the survival of the fittest. In testing local varieties of corn unaffected by modern ideas of selection alongside of the improved varieties, Professor Grantham states that the local varieties yield about as well as the others. The writer can partially verify this statement for southwestern Missouri. On his own farm there is a variety of corn that has been grown there for at least thirty years. The best ears of this variety are decidedly slick; on good land it has yielded 80 bushels per acre. A single year's test of one of the noted improved varieties in comparison with this local one indicates that the improved variety will outyield the other considerably, but it is important to note that the improved variety, although selected for excellence for fifty years, has never been selected for uniformity of type and has not a few slick ears in it.

The amount of careful investigation that this question of relation of type to yield has received is wholly inadequate. It ought to receive careful attention at the hands of our best investigators.

There is another method of breeding open-pollinated crops, like corn, that, while it has not been extensively tried, seems to deserve consideration. This method consists of maintaining two pure strains which are not close kin, and raising each year seed which is a cross between these two varieties and using this seed for the field crop the next year. This method was first proposed by Dr. G. H. Shull[a] in an article read before the American Breeders' Association at its Washington meeting in January, 1908. Shull's results have been confirmed by Dr. E. M. East, of the Connecticut Agricultural Experiment Station, whose work is referred to later in these pages. A similar plan was recently proposed by Mr. G. N. Collins, of this Bureau, in a bulletin entitled "The Importance of Broad Breeding in Corn."[b]

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[a] See Report, American Breeders' Association, vol. 4.

[b] Since the above was written, Mr. Charles P. Hartley, of this Bureau, has called the attention of the writer to some recommendations made in 1893 and 1894 by Prof. G. E. Morrow and his assistant, Mr. F. B. Gardner, of the Illinois Agricultural Experiment Station. In Bulletin 25 of the Illinois station these investigators say: "The fact that increased yields can be obtained by crossing two varieties is pretty certainly

A representative of the Office of Farm Management several years ago reported that in a certain community in one of the Western States farmers generally planted white and yellow corn in alternate rows in their seed patches. In this way they were sure of getting the vigor that comes from hybridization in the corn to be used for the general field crop the next year. Some of the farmers simply planted their whole field in alternate rows of yellow and white corn, and the next year used seed selected out of this field for planting. The next year they would go back again and get pure yellow and pure white corn from some outside source and start over again, but this is a crude method which gets advantage of the hybridization only every other year. A better plan would be to get two good varieties of corn, both known to be adapted to the conditions, and plant a seed patch somewhat more than twice as large as needed to produce seed for the fields the next year, planting the two varieties in alternate rows in the seed patch. In one-half of the seed patch one of these varieties is detasseled and in the other half the other variety is detasseled. On both sides of the seed plot the detasseled stalks would bear only hybrid grains. On the other hand, the stalks that were not detasseled would be fertilized by pollen from stalks of the same variety, except in the middle of the patch, where there would be some cross-pollination between the two varieties. At harvest time pure seed of the two varieties is selected for the next year's seed plot from the extreme sides of the plot, where there has presumably been no cross-fertilization between the two varieties, while seed for the general field crop is selected from the detasseled stalks

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established, and a few farmers are changing their practice accordingly. This is quite easily done, by planting in one row one variety, and in the next another variety, and removing the tassels of the one as soon as they appear. The ears forming on the rows having the tassels removed will be fertilized with pollen from the other rows, thus producing a direct cross between the two varieties. The seed should be selected from the rows having the tassels removed, and the experiments indicate that it will pretty certainly give a larger yield than the average of the parent varieties when planted under like conditions."

In a comparison of five crosses with the average yields of their parents the average increase in yield due to having crossbred seed in the experiments above referred to was 9.5 bushels.

Again, in Bulletin 31 of the Illinois Agricultural Experiment Station the same authors make this recommendation: "Farmers can produce crossbred seed in considerable quantities in the following manner: Plant with one variety in one planter box and another variety in the other. Remove the tassels of one variety before they begin to shed pollen, and the shoots of the same will be fertilized with pollen from the other variety, thus producing a direct cross. The seed should be selected from the rows from which the tassels have been removed."

In three out of four comparisons between crosses and their parents reported in the bulletin last referred to the crosses outyielded the parents, the average increase being 2.3 bushels per acre in favor of the crosses.

from the whole plot. This method would take advantage of the well-known vigor which arises when two varieties of corn are crossed.

Shull has recently proposed a plan somewhat similar to the above, and one which is really an improvement on it in one respect, but not so good in another.[a] He suggests using two pure strains, planting one of them off by itself to get pure seed of it for the seed patches the next year, while at the same time another seed patch for growing field seed is planted of alternate rows of the two varieties. In this patch all the stalks of the variety grown alone in the other patch are to be detasseled. All the seed produced by the detasseled stalks will be heterozygote, while all the seed on the remaining stalks will be pure bred of the other strain from that planted alone in the smaller patch. The principal difficulty with this plan is that of finding isolated spots for two seed patches instead of for one, as in the plan in which the two varieties are both planted in alternate rows in one patch. In Shull's plan the two strains could be kept practically pure; in the other plan they would mix to a slight extent.

HYBRIDIZATION AND SELECTION.

We have been considering only the effect of selection without deliberate hybridization or cross-fertilization, except such as occurs naturally in certain of the crops considered. We shall now consider the application of artificial cross-fertilization and subsequent selection to the art of improving farm crops.

As in the case of selection alone, the methods and results differ for vegetatively propagated, close-fertilized, and cross-fertilized crops.

VEGETATIVELY PROPAGATED CROPS.

It is perhaps easier to secure the advantage of hybridization in vegetatively propagated crops, such as fruits, berries, potatoes, hops, and sugar cane, than it is from those crops that reproduce from seed. The reason for this is that some of the heterozygote forms which occur in the first generation of the hybrid may be highly valuable, and these heterozygote forms can be propagated true to type because they are not propagated from seed. For instance, suppose we cross two varieties of apples or potatoes and get in the first generation a plant from which can be made a valuable new variety. All that is necessary is to propagate this new variety by cuttings.

In the case of potatoes very little hybridizing has been done. The seedling plants do not attain their full development until propagated from the tubers for two or three years. It is therefore necessary gradually to eliminate the poorer stocks and to grow for some time a good many of the forms which result from crossing, to see whether or not they are valuable.

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[a] See Report, American Breeders' Association, vol. 5.

It must also be remembered that nearly all crops which are propagated vegetatively belong to the class of crops which naturally cross-fertilize; so that when we make a cross between two of them we are really crossing things that are themselves many times hybrid. For instance, a Baldwin apple tree is heterozygote for a good many of its characters. For this reason it produces many kinds of pollen and ovules, and when we use the Baldwin in a cross we get numerous different varieties in the first generation, while if the two varieties used in the cross were completely homozygote for all their characters all the first-generation hybrids would be alike.

SELF-FERTILIZED SPECIES.

The principles involved in the hybridization and subsequent selection to type of close-fertilized species, like wheat and oats, have already been stated in more or less detail, but some additional points need to be brought out. In utilizing hybridization in close-fertilized crops the first problem is to select suitable forms for hybridization. Sometimes these forms are already at hand and well known. The real object to be accomplished by hybridization in this case is to make use of the law of recombination, by which we can bring together in one variety certain valuable characteristics which are found scattered among two or more varieties which we may have at hand or can secure. Take, for instance, the problem which presented itself, while the writer was agriculturist at the Washington Agricultural Experiment Station, in connection with wheat growing in eastern Washington. When the writer first went to Pullman, where the experiment station is located, the farmers had been growing wheat in that section for twenty-five or thirty years. They had tested many hundreds of varieties, but found very few of them adapted to local conditions. Only three varieties had at that time come into general use, and these three were each more or less restricted to definite areas of different rainfall. For instance, where the rainfall was 10 or 12 inches almost the only variety grown at that time was Bluestem (not the hairy chaffed Bluestem of the middle Northwestern States). This was grown for two reasons. In the first place, it was one of the very few varieties found that would grow tall enough to cut with so little rainfall. In the second place, it produced a very superior quality of flour, and millers paid about 3 cents a bushel more for it than for other varieties. But this tall-growing variety could not be grown where the rainfall was 20 inches or more, because it would fall down if the season was at all unfavorable. Where the rainfall was about 18 inches a variety of club wheat known as "Red Chaff" was very widely grown, while in those sections where the rainfall was 22 inches or more the prevailing variety was another club wheat known as "Little Club."

The growers of Red Chaff gave as their reasons for using this variety that it stood up better than Bluestem and yielded more than Little Club, while the growers of Little Club stated that this was the only variety they had ever found that would stand up and hold its grain under their conditions.

It happens that all three of these varieties are spring wheats, but long experience has shown that sowing them in the fall would, in favorable seasons, produce yields 30 to 60 per cent greater than spring sowing. Hence, all three varieties were generally sown in the fall, but they would frequently freeze out to a greater or lesser extent. There was therefore an insistent demand for winter wheat. The writer had collected from various parts of the world an extensive series of winter wheat varieties, and in 1899 a large number of these varieties had been grown for five years. Many of them were perfectly hardy and made enormous yields in favorable seasons, but they were inclined to straw-fall and to shatter their grain as soon as they were ripe; so that it did not seem advisable to recommend any of them to the farmers.

At that time Mendelian principles were unknown in this country and had been forgotten in Europe, so that the writer had intuition alone to guide him in his attempts to produce a variety of wheat adapted to local conditions. By chance these intuitions proved to be correct and led to the discovery of the law of recombination previously stated. Fortunately, the work proceeded from the beginning just as it would have done had the writer had full knowledge of the law of recombination, for the law was discovered in time to use it as soon as it could have been used in this work.

Eleven of the best yielding winter varieties were crossed with the Little Club and the Red Chaff varieties (the Bluestem could not be successfully grown at Pullman, where the rainfall was about 22 inches). Among the first-generation hybrids there were, therefore, eleven kinds. The seed of each hybrid plant was saved separately, so that the next year we had as many plots as we had hybrid plants the year before.

The object of this hybridization work was to combine the winter hardiness of one class of varieties with the stiff straw and the tightly closed chaff of the other varieties. We now understand why this combination succeeded in every one of the crosses, so that from each of them resulted new and fixed varieties of wheat combining the characteristics mentioned. As was to be expected, some of the new varieties proved to be much more productive than others.

The writer severed his connection with the Washington Agricultural Experiment Station at the beginning of 1902, but his successor and his assistants continued the work with the hybrid wheats, and this work is still in progress, being conducted by Mr. C. W. Lawrence, of the Washington station.

Three of these hybrid varieties (which had been fixed by proper selection, methods of which are outlined below) were distributed in small quantities to the farmers in the fall of 1907 after having been carefully tested at the experiment station as to their yielding power. In the fall of 1908, 39,000 acres of these new varieties were reported as being sown by the farmers in eastern Washington. In two more years there will doubtless be seed enough for all.

The case just cited illustrates one in which hybridization furnishes a means of securing new and valuable varieties, namely, the case where certain valuable characteristics are found in different varieties and it is desirable to unite these characteristics. Such cases would exist at most plant-breeding stations. Doctor Nilsson, at Svalöf, has made extended use of these principles in producing new varieties of cereals at his station. The first task is to select the varieties having desirable characteristics. Frequently some of the characteristics will be found in varieties that are otherwise worthless, so far as their use as field crops is concerned, so that in breeding work a variety should not be rejected because of a single weakness. It is legitimate to use an inferior variety in crossing, provided it has some valuable characteristics.

In working with self-fertilized crops the principles involved for the first two years are exactly the same as those in cross-fertilized crops illustrated in Table VI. The first generation of the hybrid is heterozygote for all those characteristics in which the two parent varieties differ. Where the parents differ in a great many respects the problem becomes quite complex, for the number of types that will be produced in the second generation is equal to 2^n, n being the number of points in which the two parents differ. Thus, when they differ in one particular, that is, when we have one pair of allelomorphs to deal with, there are two distinct types in the second generation of the hybrid. If the parents differ in two respects, we have $2^2=4$ distinct types in F_2 (the second generation of the hybrid). Three differences give $2^3=8$ types, and so on. The figures given above assume that in each pair of allelomorphs there is complete dominance, so that the heterozygotes can not be distinguished from the pure dominants. If the heterozygotes can be distinguished, then the number of visibly different types in the second generation is 3^n. In fact, in so far as their content of hereditary characters is concerned there are always 3^n types in the second generation when the varieties crossed differ in n particulars. In many cases we can neglect a great many of these differences, because they are immaterial and deal only with those character pairs which are important. Table VI shows what occurs when the parents differ in two respects. The first generation is heterozygote with respect to both character pairs. In the second generation nine types occur in the proportion shown in Table VI.

In the third generation we get a different result with self-fertilized plants from that obtained in cross-fertilized plants, because in self-fertilized species a heterozygote when it makes seed breaks up into one-fourth pure dominants, one-half heterozygotes, and one-fourth pure recessives; while with open-pollinated species the proportion of heterozygotes produced by heterozygotes will be larger than one-half, because of the introduction of foreign pollen.

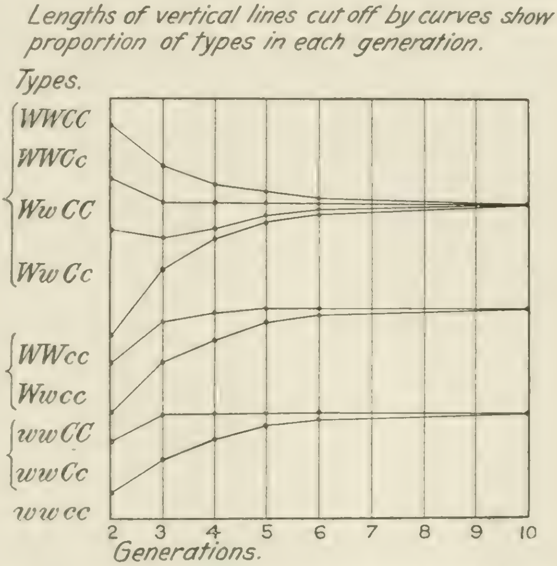

FIG. 4.—Graphic illustration of ten generations of a hybrid in a self-fertilized species without selection to type: W, winter character; w, absence of W (i. e., spring character); C, club character (short, thick heads); c, absence of C (i. e., long-head character). Types arranged so as to bring together those that resemble each other. The space between the top horizontal line and the uppermost curved line shows the proportion of type $WWCC$ present from generation to generation, and the space beginning opposite each type formula shows the proportion of that type. The population ultimately consists almost entirely of the four homozygote types present.

Let us first consider what occurs in self-fertilized species if we make no selection at all among the progeny of the hybrid. Figure 4 shows what occurs in this case. Suppose the plant with which we are dealing is a hybrid between a long-headed winter wheat and a club or short-headed spring wheat. In the second generation we get the usual nine types, as seen at the left of figure 4, where W = winter character, w = spring character, C = club heads, and c = long heads. The nine types are arranged in figure 4 so as to bring together those which appear to the eye to be alike. Thus the types $WWCC$, $WWCc$, $WwCC$, and $WwCc$ are all winter clubs, since W is dominant over w and C is dominant over c. $WWcc$ and $Wwcc$ are long-headed winter wheats, $wwCC$ and $wwCc$ are spring clubs, while $wwcc$ is a long-headed spring type.

The relative proportion of each of these nine types for a series of generations, from the second to the tenth, is shown in the diagram of figure 4. For instance, the proportion of type *WWCC* is indicated by the space between the top horizontal line of the diagram and the upper one of the curved lines. The generations are indicated by the figures at the bottom of the diagram. In generation two the space for type *WWCC* is narrow, constituting only one-sixteenth of the second generation. But this type increases from generation to generation until by the tenth generation it is practically one-fourth of the population; that is, when there is no selection to type.

Type *WWCc* is seen to decrease from generation to generation, as indicated by the space between the two upper curved lines. This space gradually becomes narrower, so that it has practically disappeared by the tenth generation. The space beginning opposite each type formula shows what happens to that type. It is seen that the four homozygote types *WWCC*, *WWcc*, *wwCC*, and *wwcc* gradually increase in proportion while all the heterozygote types decrease. By the tenth generation the whole population consists practically of the four homozygote types, each of them constituting practically one-fourth of the population. Only small amounts of any of the heterozygote types remain in the tenth generation. Of these four homozygote types, two of them will be just like the two parents, as far as the characters we are considering are concerned. The other two will represent new combinations of the characters under consideration; the new types are (1) winter character with club heads and (2) spring character with long heads. We may therefore in such cases (i. e., with self-fertilized crops) secure our hybrid and plant its seed for several years without any selection at all, then select out the type we want and it will be almost entirely pure; that is, nearly all the plants selected will reproduce true to type as far as the characters wanted are concerned. Then selecting individual plants of the type wanted we can quickly get plants that are homozygote with reference to practically all their characters by planting the seed of each plant separately and observing which of them do reproduce true to type.

These fixed forms which occur in the progeny of hybrids are sometimes mistakenly called "mutations." They are in no sense mutations of the sort comprehended by that much misused term as it is at present understood. They are simply recombinations of characters which, before the hybridization occurred, existed in different combinations.

After these fixed forms are obtained the same laws apply to their selection as have already been described under the effect of selection on close-fertilized forms. Generally speaking, we can not modify them by selection, but selection may be valuable as a means of holding them up to a high standard.

Reverting again to the hybrid produced by crossing long-headed winter wheat with a club-headed spring wheat we shall now consider the effects produced, first, by mass selection and, second, by individual selection in the progeny of such a hybrid. Figure 5 shows the result of mass selection for the winter club type. Since both the winter character and the club character are dominant in this cross, four of the nine types occurring in the second generation will appear to be winter club wheats. These are the upper four types of figure 5. The other five can be distinguished at once, because they will either show the long-head character or the spring character. To determine whether or not a wheat is winter or spring in character it should be planted in the spring. If it makes a crop the same season it is a spring wheat. If it waits until the next season before it heads out it is a winter wheat. The four types in the second generation which appear to be winter club wheats are those having the constitution *WWCC*, *WWCc*, *WwCC*, and *WwCc*, in which *W* stands for the winter character, *w* for the spring character, *C* for the club character, and *c* for the long-head character. The first of these four types is already fixed and will reproduce itself faithfully. The others are heterozygote with reference to one or both character pairs, and will consequently the next year produce some progeny which will be either spring or long-headed wheat, or both. Suppose, now, that in the second generation we discard everything except these four types. Figure 5 shows what the result will be. The diagram of figure 5 is easily interpreted if we understand that the space between the top horizontal line and the uppermost curved line represents type *WWCC*, the space between the two uppermost curves represents type *WWCc*, and so on. It is seen that in the third generation, type *WWCC* has increased greatly in

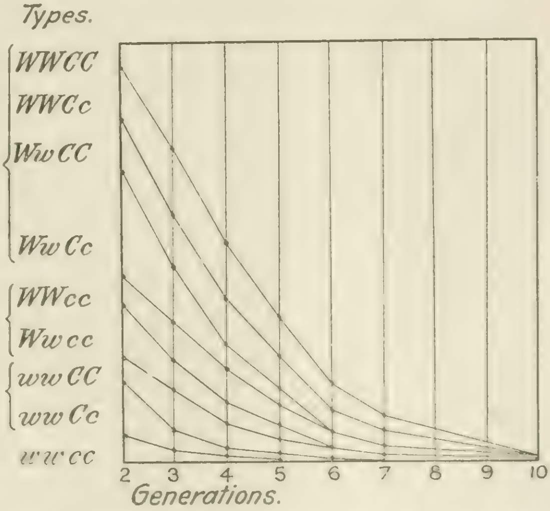

FIG. 5.—Graphic illustration of ten generations of a hybrid in a self-fertilized species selected for type *WWCC*. The letters and spaces between curves have the same significance as in figure 4.

proportion. Type *WWCc* about holds its own until the fourth generation, after which it decreases. The same is true of type *WwCC*, but type *WwCc* decreases rapidly from the second generation onward. At the end of ten generations practically the whole population is of type *WWCC*, which is pure winter club wheat, with a very small admixture of other types. This shows the effect of mass selection after hybridization in the case of self-fertilized crops. The result is a much more rapid approach to the one type selected than occurs in the corresponding case with cross-fertilized crops as shown in figure 3.

The effect of individual selection, i. e., selection in which the seed of the individuals selected is kept separate, is shown for self-fertilized crops in figure 6. In this figure, as in the preceding, the space beginning opposite each type symbol shows the proportion of that type from generation to generation. In this method of selection we save each second-generation individual which appears to be of type *WWCC*. This includes all plants of types *WWCC*, *WWCc*, *WwCC*, and *WwCc*. The seed of each plant is kept separate. In the next generation we save seed only from those rows or plots in which there has been no splitting up. This gives us at once the type *WWCC* in pure and fixed form. This is shown in figure 6, where the space representing type *WWCC* occupies the whole diagram beyond the third generation.

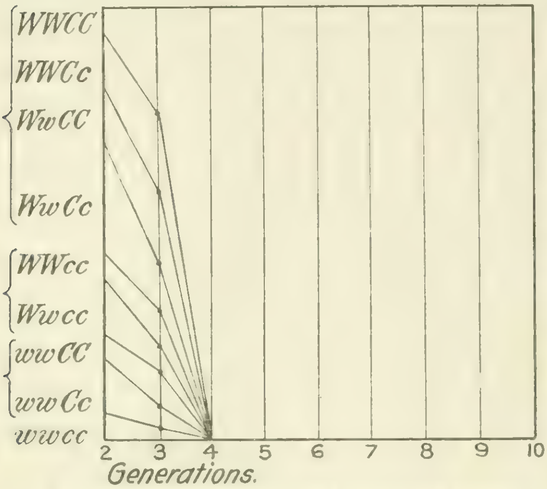

FIG. 6. Graphic illustration of the effect of individual selection in a self-fertilized species on progeny of the hybrid *WwCc*. After the third generation the race is pure for the selected characters (both dominant in this case). The letters and spaces between curves have the same significance as in figure 4.

CROSS-FERTILIZED SPECIES.

The problem of utilizing hybridization in the production of new forms in cross-fertilized species which are propagated from seed is somewhat complicated by the fact that the individuals to be used in crossing may themselves be heterozygote for many characters. Diversity in such species differs from that in self-fertilized species in this respect: In the latter we usually have in homozygote form all the combinations possible of the characters found in the group, while in cross-fertilized species we have the same combinations, but not in homozygote form. In self-fertilized species, when a desired combination is not at hand, we can easily produce it and get it in fixed form. In cross-fertilized species, if the desired combination is not at hand, we can get it by crossing, but can not be sure of keeping it unless it is a form that can be propagated vegetatively, such as berries, tree fruits, and potatoes. The best we can do in cross-fertilized species which are propagated from seed is to make a cross with a view to getting a certain desired combination of characters and then select the desired type until we get a fairly constant strain of it. The results that follow such selection have already been explained under the head of "Cross-fertilized species," page 36, and illustrated in figure 3.

It has already been hinted that in cross-fertilized species we should not try for too great uniformity, as such uniformity in cross-fertilized species usually goes with weak development. If by crossing and subsequent selection we can get two forms, each of which is homozygote for the same desirable characters but heterozygote for other characters which are of no importance, and then plant them so that the two forms will cross freely, we shall probably have the nearest approach to the desired end attainable in such forms.

MENDELIAN ANALYSIS OF HETEROZYGOTE RACES.

When an individual which is heterozygote for a given pair of allelomorphs is self-pollinated it breaks up in the next generation into three forms, or types, two homozygote and one heterozygote. Let our pair of allelomorphs be represented by Aa. With self-pollination we have in the next generation one-fourth AA, one-half Aa, and one-fourth aa. That is, one-fourth of the seed produced is homozygote for A, one-fourth for a, and one-half of it is heterozygote, Aa. Hence, in such species as apples, pears, strawberries, and cassava, which do not ordinarily reproduce true to seed because they are heterozygote, usually for many of their characters, if we self-pollinate them, in the next generation we get many forms that are homozygote for some characters. If the species will endure continued self-pollination it is clear that we could in eight or ten generations break up any variety of this kind into homozygote types that would reproduce true to seed. In fact, there are a good many varieties of some of the species just mentioned that do reproduce practically true from seed. The Royal Anne cherry of Oregon and Washington is a case in point. Many of its seedlings can hardly be distinguished from the original variety. Where it is possible to secure these homozygote forms by this process of breaking up into pure races, a process which we may call Mendelian analysis, such forms might be of great importance to the breeder. They might render possible the deliberate combination of highly desirable characteristics existing in different varieties. Some very interesting work of this kind has been done. Prof. S. M. Tracy, working under the direction of the writer, has thus obtained three races of cassava which reproduce practically true to seed. They are now being used in an attempt to propagate this crop from seed instead of from cuttings. If the attempt is successful, and it promises to be so, it will permit a considerable extension of cassava culture into latitudes in which it is not practicable to propagate cassava from cuttings, because of the difficulty of keeping the cuttings over winter.

In Volume V of the Annual Reports of the American Breeders' Association, Dr. W. T. Macoun, of Canada, reports some very interesting facts regarding the seedlings of the Wealthy apple. There was probably some cross-pollination in this case, but the seedlings give very plain evidence of the parentage of this important variety of apple. This is an important and nearly virgin field of investigation, and more work of this kind will be looked for with interest.

HETEROZYGOTE CHARACTERS.

In some crosses, or hybrids, characters appear in the first generation of the cross that were not apparent in either parent. These characters may belong to either of two classes. First, they may be due to the heterozygote nature of the hybrid. Characters of this class can be taken advantage of by the breeder only when the plant concerned can be propagated vegetatively. In crops propagated from seed a character which is due to the heterozygote nature of the plant which bears it will appear in the next generation in only half the progeny. Such characters can not be fixed by selection; at least no one has as yet succeeded in doing so, and it is highly improbable that it can be done.

The most common type of such characters is the well-known vegetative vigor seen in many hybrids. It is not unusual in sorghum fields to see here and there a stalk which is much larger and taller than the rest of the field. Investigation has shown that these plants are hybrids. The writer has noticed in his work with hybrid wheat that the first-generation hybrid is much more vigorous and stronger growing than either of the parents as a rule, though this vigor in hybrid wheats is not so marked as it is in sorghum. In corn it is especially marked. Dr. G. H. Shull by the close breeding of two varieties secured practically homozygote strains of them, which were then crossed. The yield of the hybrid was about five times that of the attenuated self-fertilized pure strains. It should be remarked that the pure strains of corn, because of the close inbreeding, had become very weak yielders, while the hybrid yielded an exceedingly large crop.

Dr. E. M. East, of the Connecticut Agricultural Experiment Station, in a similar manner produced on small plots at the experiment station yields of corn exceeding 200 bushels per acre from hybrid seed. Here is an important point for the corn breeder.

A good deal of effort has been made to secure uniformity of the ears in corn by a system of rather close breeding. This method will give the desired uniformity, but the close breeding in a species naturally cross-fertilized is likely to lead to lessened yields. Is it not better to breed for excellence, taking care not to breed too closely, and let uniformity take care of itself? A method of using two strains of corn in the breeding plot in order to secure hybrid seeds for the field crop has already been described.

Increased vegetative vigor does not occur in all crosses. Before recommending the cross-breeding of any particular crop in order to secure increased vigor, the fact that in that crop the desired results will follow should be determined.

The following are other cases of characters which occur only in heterozygote form. In the cross between Black Andalusian fowls and a variety of White Andalusians having black splashes on the feathers, here called White Andalusians for convenience, the heterozygote is blue. If these blue fowls be mated with each other one-fourth of their progeny is black, one-half blue, and one-fourth white. If Blue Andalusians are desired, 100 per cent of blues can be obtained only by mating blacks and whites.

According to Professor Bateson, exactly the same phenomenon occurs in the Bredas, a breed of fowls found in Holland.

A similar case occurs in the cross between a certain red primrose and a certain white primrose, reported by Professor Bateson. The heterozygote is purple and is known to the trade under the name of "Imperial Primrose." Fifteen years of persistent selection has failed to cause this primrose to come true to seed. Every year one-fourth of its seed produce plants having red flowers, one-half of the seed produce plants having purple flowers, while the remaining one-fourth have white flowers.

Dr. G. H. Shull found a mottled character in the seed coat of certain first-generation hybrid beans which proved to be a heterozygote character; that is, when it appeared it was always heterozygote and would then reappear in only half of the plants whose seeds were mottled. Prof. R. A. Emerson, of the University of Nebraska, found the same character in beans, as did also Professor von Tschermak, of Vienna, and Mr. Locke, of Ceylon.

Cases like those cited seem to be due to the presence of two characters in different varieties which are not manifest in those varieties; but when brought together by hybridization they react on each other in some unknown manner so as to give rise to a new character. At the same time they form a Mendelian pair and separate again on the formation of gametes. Perhaps in such cases two chromosomes, which meet to form a bivalent in the reduction division, each throw off into the cell a different chemical substance, and these two substances, by reacting on each other, give rise to the new character. When these two chromosomes are not together in the same cell the character does not appear.

Most of such characters are probably reversions to lost characters. The fact that there are mottled races of beans like those produced by Shull and others, and which reproduce true to seed, is in favor of this suggestion. In these mottled beans which reproduce true to type we may suppose that each of the chromosomes in question produces both of the chemical substances which we have supposed give rise to the character. If this is the case, then nonmottled varieties of three types could arise from a mottled variety by the loss on the part of the chromosomes producing the two necessary substances of the power of producing one or the other or both of these substances. If in one variety of beans one of these substances and in another variety the other substance is missing, crossing the two varieties would cause the lost character to reappear. This matter will be considered more fully when we are considering the subject of latency of hereditary characters.

Thus far we have considered only those new characters arising in crosses and which appear only in heterozygote form. There is a second class of characters arising in crosses that may be fixed by proper procedure. In working with gillyflowers Bateson and his coworkers found an interesting case of this kind, which will be considered more fully under the head of latency and need only be referred to briefly here. In crossing a certain white variety with a cream-colored variety the progeny produced red flowers, and in the second generation some individuals were obtained having red flowers and reproducing true to seed. Evidently this result was due to the fact that two characters neither of which produced any effect when alone but when brought together gave rise to a visible character did not form a Mendelian pair and could consequently both be transmitted together.

The reason why a character of this type can be fixed is seen in the following. We have assumed that the new character arises by the bringing together of two other characters that are not allelomorphic to each other; that is, do not form a pair which must separate on the formation of gametes. If we call one of these characters *A*, its absence *a*, the other *B*, and its absence *b*, the first-generation hybrid is constituted thus, *AaBb*. This hybrid produces four types of gametes, namely, *AB*, *Ab*, *aB*, *ab*. An ovule of the type *AB* uniting with pollen of the type *AB* gives *AABB*, a homozygote strain in which the new character is fixed. While such cases as this are not common, they may occasionally represent important advances in breeding. It is therefore well for the breeder to understand them. Several such cases have been found. They also probably represent reversions to lost characters, at least in most cases.

Characters may also appear in the second generation of a hybrid that were not apparent either in the first generation or in either of the parents. This is especially the case when a character is hypostatic in one of the original parents of the cross; that is, when it is covered up or hidden by some other character. A case in point is the appearance of brown beans in the second generation of the cross between black and white, reported by Shull. Here the brown is hypostatic to black, i. e., obscured or hidden by the black, in the black parent. Letting *B* represent black, *b* its absence, *D* brown, and *d* the absence of brown, the formulæ for the black and white forms and the hybrid between them is—

Black, *BBDD*.
White, *bbdd*.
Hybrid, *BbDd*.

The gametes produced by this hybrid are *BD*, *Bd*, *bD*, and *bd*. The union of an ovule of the type *bD* with pollen of the same type gives *bbDD*, a brown type.

Similar cases are known in animals.

POSSIBILITY OF ENTIRELY NEW CHARACTERS.

While most apparently new characters that arise in crossing are probably reversions to lost characters, it is easily conceivable that entirely new characters might arise in this manner. It seems probable that some cases of reversion are due to reaction between chemical substances, one of which is derived from one parent and the other from the other. These substances are probably produced in the cells of the respective pure strains before the cross; but they produce no effect because they are not both present in the same cells. It is conceivable that in some races there may have occurred evolutionary changes that result in considerable modification of the chemical contents of the cells but which produce no visible effect on external characters. In two related races these evolutionary changes may be quite different, and when we cross two strains that have been separated for some thousands of generations we may get, by reactions between substances that in the respective pure races are of no effect, entirely new characters which thus seem to appear suddenly, but which in reality may have been thousands of years in developing. Characters arising in this way would appear only in heterozygotes if the two factors brought together happened to form a pair. But if they did not form a pair the new character would be capable of being fixed.

Some phenomena have occurred, especially in crosses between distinct species, which probably belong in the class here considered, though not enough work has been done in this direction to make this entirely certain.

RECIPROCAL CROSSES.

If in one cross we use the pollen of race *A* on the stigmas of race *B*, while in another cross we use the pollen of race *B* on the stigmas of race *A*, these two crosses are said to be reciprocal to each other. Ordinarily such crosses give identical results. In his work with hybrid wheats at the Washington Agricultural Experiment Station the writer made reciprocal crosses in three instances, and in each case the results of the reciprocal crosses were identical. There are cases, however, where reciprocal crosses give different results. In some species the plant produces more than one kind of pollen and only one kind of ovule, as Correns found in Bryonia. He crossed a diœcious species with a monœcious species. When he used pollen of the diœcious species the hybrids were male and female in equal numbers, but when he used the pollen of the monœcious species the hybrids were all female. A number of other cases are known which may be explained on a somewhat similar basis. In a few cases differences have appeared in reciprocal crosses for which no explanation has been found. The plant breeder should make a careful record of any such cases coming under his observation, as they may lead to important advances in our knowledge of the principles of heredity.

EVOLUTIONARY CHANGES AND THEIR RELATION TO PLANT BREEDING.

While a great deal of study has been given to the general subject of evolution, actual knowledge of how and why evolutionary changes occur is very limited. The discussion this subject has received has been largely theoretical, and usually in support of some theory as to the manner in which such changes occur.

We may perhaps distinguish two or more classes of evolutionary changes. A complex organism is provided with many hereditary characters—that is, characters which appear in successive generations. These characters may change in the manner of expression. For instance, a species having purple flowers may change with reference to the shade of coloring, or a variety may change in size, and so on. Again, a character may become latent, possibly lost entirely. Thus, a purple-flowered species by the loss or latency of a factor for purple, may become red. Again, a red flower might become purple by the revival of the latent factor for purple.

It is probably safe to say that most evolutionary changes are of the classes mentioned in the preceding paragraph. Take, for instance, the color of wild mammals. Nearly all mammals, so far as they have been studied, have the same factors for color. The differences in the colors of the different species have come about simply by modifications in these same factors. Yet, some evolutionary changes result in the development of new characters. Beards on grasses must at one time have been new organs. But changes of this kind are comparatively rare, and occur so seldom that we can take little cognizance of them in practical breeding work.

As stated before, we do not know the cause of these changes. One school of biologists maintains that evolutionary changes are slow and gradual, another that they take place by instantaneous steps, which may be large or small—that is, that they are "discontinuous." We are more interested here in the amount of change that may occur in a given time than in the manner in which such changes take place. The important point is that when evolutionary changes do occur they are usually permanent changes, and the new forms resulting are subject to the laws of selection and hybridization which have already been outlined. That these permanent changes do occur can not be questioned. That in general they are merely changes in hereditary characters already present is equally certain. Doctor Nilsson in his work with the cereals at Svalöf has many times taken an unselected lot of seed from a standard variety of field grain and found it in the main to consist of a large number of fixed types differing from each other in various ways. When the same character is studied throughout the numerous strains that occur in a field it is found to present nearly every possible gradation in different strains, but generally speaking in each of the strains the gradation found is fixed.

Jennings, in his study of Paramecium, found in wild cultures almost an indefinite number of strains, each differing permanently in size, and these differences undoubtedly are due to permanent changes of hereditary characters, as in the case of Nilsson's cereals. Jennings's investigations indicate that there might be found in Paramecium almost every gradation in size, but that the size of each particular strain is fixed.

The principal relation of these changes to the work of the plant breeder lies in the fact that a crop as grown under field conditions will usually consist of a large number of strains which differ from each other on account of evolutionary changes which have occurred in the past, and the breeder can by selection secure the strains which are of greatest value.

A few instances are known in which important changes have been brought about by persistent selection. De Vries, by continued selection from a 13-rayed strain of *Chrysanthemum segetum*, was finally able to produce a double-flowered variety. Burbank found a single specimen of California poppy which had a scarlet line on one of its petals. By persistent selection from this plant he was able to get a scarlet poppy. Cases of this kind are not understood, yet they are important from the standpoint of the breeder. They show that we have much yet to learn in this important field. It may be stated that scarlet-flowered California poppies occasionally occur in nature. This fact shows that at least part of the species has the scarlet color factor. It is probable, therefore, that Burbank started with a plant having this factor, and by selection merely eliminated other color factors.

PLACE EFFECT.

It is a well-known fact that when a crop is moved to a locality which is radically different from that in which it was previously grown it sometimes behaves in a surprising manner, presenting unlooked-for variations. This subject has not been studied nearly as much as it ought to be. We really do not know the behavior of the variations which occur under such conditions, because so little attention has been given to them.

Take, for instance, the case of the tomato in southern climates. Some of the standard varieties of tomatoes present very peculiar modifications when seed grown in the North is planted in the far South. The first year the fruit is normal and resembles the fruit that would have been produced in the North; but if seed of the southern-grown fruit be saved and planted, the next year the fruit is of a very different character and remains so from generation to generation under the new conditions. The writer is informed by Mr. W. W. Tracy, sr., of this Bureau, that when the seed of these transformed tomatoes is taken back to the North and planted, while the first year it grows the southern type of tomato, the next year it reverts to its northern form. Cases of this kind are well worth more attention than they have received.

It is to be noted that in the case of the tomato just referred to the same change occurs in all the individuals. In this connection, some work recently done by Dr. Albert Mann, of this Bureau, is of special interest. Although the results are as yet unpublished Doctor Mann kindly permits me to refer to them.

Three years ago he obtained from Doctor Nilsson, of Svalöf, a number of the pedigreed or pure-line strains of barley grown at that station. Seed of five or more of these were sent to thirty-eight localities throughout the country in 1907, representing nearly two hundred tests. In all cases more or less transformation occurred in each of the strains under investigation. Generally speaking, every individual of a given strain went through identically the same transformation in the same locality. The results obtained the second year on some thirty locations indicate that the changes made by these plants are permanent as long as they are grown under the new conditions.

In several instances it was found that a given strain did not behave alike, part undergoing one modification and part another. A careful study of one of these cases revealed the fact that one end of the plot was on sandy soil and the other on loam and that all the plants at the same end had suffered the same change.

Doctor Mann has called my attention to the important fact that these changes suffered by pure lines when taken to a radically different environment from that to which they had been accustomed seem in no way to be adaptive changes. They are apparently not adjustments to the new conditions, but are changes caused by the new conditions. Apparently, they may be advantageous or disadvantageous to the plant under its new surroundings.

It is easily seen that by studying this question with types of plants from which all other kinds of variation have been eliminated, results of fundamental importance may be obtained. The conclusions, which are at least indicated by the very meager data at hand, are that these new-place effects produce similar results on similar individuals, that they are permanent under the changed conditions, and that they are fortuitous in character. It is by no means established, however, that these conclusions are general. This is evidently an important and nearly virgin field for investigation.

NON-MENDELIAN CHARACTERS.

The only case known to the writer of a non-Mendelian character which has been clearly made out and for which the method of inheritance has been determined is one recently published by Dr. Erwin Baur, of Berlin, and which relates to the method of inheritance of the white margin of certain leaves.[a] The white-margined plants produce only pollen and ovules carrying the white tissue character. But when these plants are crossed with ordinary green plants the new individual thus formed is capable of producing both kinds of tissue. It would appear that in the cross-fertilized ovule, part of the cytoplasm of the cell carries the tendency to develop green tissue and part the tendency to develop white tissue. If at any cell division one of the daughter cells should happen to receive only cytoplasm of a certain kind then the tissue descended from that daughter cell will be either pure white or pure green, as the case may be. Plants originating from this cross between white and green are thus called mosaics. A leaf or bud originating on the line of contact between the tissues will be white on one side and green on the other. If it originates wholly from white tissue it will be pure white; if wholly from green tissue it will be pure green. Occasionally, however, the white tissue on the stem of such plants may extend as a thin surface layer over the green tissue. A bud coming through such a layer will be composed of green tissue within and a thin layer of white tissue without, and this bud gives rise, by division and propagation, to a new white-margined plant.

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[a] Since the above was written the publication of Castle's monograph on inheritance in the rabbit has been made by the Carnegie Institution. Had this publication appeared earlier it would have received extended notice in these pages.

Another case which should be mentioned here is that of the inheritance of ear length in rabbits studied by Prof. W. E. Castle, of Harvard. The cross between long-eared and short-eared rabbits had ears intermediate in length, and their progeny were like the hybrid in this respect. In this case the mechanism of inheritance is not clear; and it is barely possible that it is simply a very complex case of Mendelian inheritance.

In a great many crosses between very distinct species we do not get strictly Mendelian phenomena and we do not know exactly why. It is highly probable, however, in the writer's opinion, that the reason is to be sought in the following. Most of the organs and parts of an organism are developed as the result of the interaction of a good many factors which are Mendelian in nature. For instance, the development of horn tissue in cattle may be the result of the interaction of three or four or even more chemical substances arising from different organs in the cell. Now, if in two races of cattle we find a difference in only one of these chemical substances, then the differences between the two races would behave as a simple Mendelian character; but if there were differences in all the substances concerned we should have an exceedingly complex case of Mendelian inheritance, the unraveling of which would require such large numbers of progeny from hybrids that it would be practically impossible to determine the nature of the inheritance in the case. The writer is of the opinion that the lack of simple Mendelian characters in species hybrids is partly of the nature here outlined. In some species crosses apparently wide departures from Mendelian principles occur. Take, for instance, the cross made by Burbank, resulting in the Primus berry. Here there was wide diversity in the first-generation hybrids. The one first-generation individual from which the Primus berry is descended was unlike any of the others. But this individual has reproduced true to seed from the beginning.

Rosenberg has shown that in a similar case in the genus Hieracium the first-generation hybrids, which are not alike, have different numbers of chromosomes. Presumably, in such cases, the chromosomes of the two species crossed differ so much in habit that they can not function together properly, and some of them are lost in the early cell divisions of the young hybrid. In some individuals, one chromosome is lost, in others other chromosomes are lost; so that, if the supposition here made is true, the young first-generation hybrids do not have the same complement of hereditary characters, which would account for their not being alike.

The fact that these hybrids do not split up in Mendelian fashion in the second and later generations suggests that the corresponding chromosomes in the two sets of chromosomes brought together in these wide crosses are so unlike that they are not drawn together to form bivalents in the reduction division. That is, the reduction division does not occur in the mother cells which produce ovules and pollen. If this should prove to be true, then either of two alternative courses of events would give hybrids which reproduce true to seed without Mendelian splitting.

(1) Seed may be produced parthenogenetically, without the intervention of a reduction division and subsequent fertilization, and this asexual production of seed may continue from generation to generation.

(2) Without a reduction division in the first-generation hybrid, a pollen nucleus may unite with an ovule nucleus, thus giving a nucleus having two sets of chromosomes like the one possessed by the first-generation hybrid. The set of chromosomes in the first-generation hybrid is presumably composed of chromosomes part of which are from one species and part from the other. The double nucleus thus formed will have two sets of chromosomes, every one in one set having an exact duplicate in the other. After this, that is, in the second and later generations, reproduction would take place in the usual manner, without any Mendelian splitting, for the two halves of each bivalent formed in the reduction division would be exactly alike.

It would probably be possible, by cytological study of these constant hybrids, to determine whether the absence of Mendelian splitting is due to either of the causes above suggested.

MUTATIONS.

The term "mutation" has been used and is now used in so many senses that a great deal of confusion has arisen in consequence. Prof. Hugo De Vries, of Holland, after investigating some hundreds of species of plants, found one species (*Oenothera lamarckiana*) which occasionally produced offspring that were unlike the parent. Some of the new individuals were capable of reproduction true to type. These forms he called mutations. The work of Dr. R. R. Gates, of the University of Chicago, who is making a careful study of the chromosome behavior in these mutants, indicates strongly that these mutations are due to accidents occurring in the reduction division by which chromosomes are either lost or gained or exchanged, so that some of the daughter cells are provided with a set of chromosomes differing from that of the parent species. A good deal of work must yet be done before this matter is settled, and until we know more about it we can not assign mutations of this class to their proper place in heredity and in evolutionary progress.

The term "mutation" has also been applied to any permanent evolutionary change of whatever magnitude or whatever its cause. It is hardly probable that all evolutionary changes are due to accidents in cell division. It would seem rather that most of such changes are due to permanent changes in whatever material is responsible for the development of hereditary characters, and it is probable that we shall ultimately have to make a distinction between these two types of so-called mutations.

LATENCY.

Characters sometimes fail to develop, although present. The reason for such failure may fall into any one of several categories. One of the most important recent papers dealing with this phase of the subject is that of Dr. G. H. Shull in the American Naturalist, Volume XLII, July, 1908. The following classification of the different types of latency follows, in the main, Doctor Shull's paper, departures therefrom being noted in the text.

I.—LATENCY DUE TO SEPARATION.

Bateson and his coworkers crossed a cream-colored strain of gillyflowers with a white strain and secured a hybrid which had red flowers. This is explained by assuming that in the cross two characters are brought together which when separated are incapable of producing red flower color, but which when together give rise to this color. Many other breeders have found similar instances, and these characters, which when alone produce no visible effect but when in the presence of other characters give rise to visible manifestations, have been called "cryptomeres" by Prof. E. von Tschermak, a term which is derived from the Greek and which etymologically means "hidden parts." Both von Tschermak and Bateson have shown that purple color in gillyflowers is due to three such cryptomeres. Two of these without the third give rise to the red color. When the third is present with the first two purple arises. There are other cryptomeres present in gillyflowers which modify these colors, but the numerical relations in their transmission have not yet been fully made out.

Shull found a cryptomeric character in beans in a cross between certain brownish-seeded beans and white-seeded beans. It appears that the white variety carried a cryptomere which when present with the factor which gives rise to the brown color converts the brown into black, thus giving in the hybrid a character which was apparently absent in both of its parents.

In this case we may represent the formula of the two parents as follows:

White parent = *BBpp*.
Brown parent = *bbPP*.

Here *B* stands for the cryptomere which converts the brown color into black (and which is latent in the absence of *P*) and *P* for the producer of the brown pigment. The hybrid would have the formula *BbPp*. The second generation of this hybrid would be as follows:

	B.	*P.*	*pb.*
1 *BBPP*	1		
2 *BBPp*	2		
1 *BBpp*			1
2 *BbPP*	2		
4 *BbPp*	4		
2 *Bbpp*			2
1 *bbPP*		1	
2 *bbPp*		2	
1 *bbpp*			1
16	9	3	4

The first column in the above table gives the nine types in the second generation of the hybrid, and the figures at the left of the formula show the relative frequency of the types. Thus type *BBPP* constitutes one-sixteenth of the second generation, type *BBPp* two-sixteenths, and so on. Since *B* and *P* are both present in types *BBPP*, *BBPp*, *BbPP*, and *BbPp*, these four types, constituting together nine-sixteenths of the second generation, will all be black. Types *bbPP* and *bbPp* are brown, while types *BBpp*, *Bbpp*, and *bbpp* will all be white, although two of them have the factor *B*. The factor *B* has no effect in the absence of *P*. We thus have in the second generation of this hybrid 9 blacks, to 3 browns, to 4 whites.

A more complex case of this kind is that of the purple gillyflowers already mentioned. In this case we have to deal with the following factors:

C=one factor of red.
R=other factor of red.
P=the factor for purple.

Of these factors *C* and *R* are cryptomeric to each other; that is, neither of them produces a visible effect except in the presence of the other. *P* is cryptomeric to both *C* and *R*. The factor *P* was first discovered by crossing a cream-colored variety carrying the factor *C* and a white variety carrying the factors *R* and *P*. The first-generation hybrid was therefore *CcRrPp*. The second generation of this cross gave the following:

	P.	*R.*	*W.* (or cream).
1 *CCRRPP*	1		
2 *CCRRPp*	2		
1 *CCRRpp*		1	
2 *CCRrPP*	2		
4 *CCRrPp*	4		
2 *CCRrpp*		2	
1 *CCrrPP*			1
2 *CCrrPp*			2
1 *CCrrpp*			1
2 *CcRRPP*	2		
4 *CcRRPp*	4		
2 *CcRRpp*		2	
4 *CcRrPP*	4		
8 *CcRrPp*	8		
4 *CcRrpp*		4	
2 *CcrrPP*			2
4 *CcrrPp*			4
2 *Ccrrpp*			2
1 *ccRRPP*			1
2 *ccRRPp*			2
1 *ccRRpp*			1
2 *ccRrPP*			2
4 *ccRrPp*			4
2 *ccRrpp*			2
1 *ccrrPP*			1
2 *ccrrPp*			2
1 *ccrrpp*			1
64	27	9	28

This gives in the second generation 27 purples, 9 reds, and 28 whites or creams.

The above illustrations will give the reader an idea of the behavior of cryptomeric characters. These characters are not infrequent, and in the early days when such cases arose they were frequently reported as "exceptions to Mendel's law." Their inheritance is now well understood.

II.—LATENCY DUE TO DOMINANCE OF ABSENCE OVER PRESENCE.

Latency due to dominance of absence over presence was not separately considered by Shull in the paper referred to. Generally speaking, the presence of a character is dominant to its absence, but there are some exceptions. Two of the best known relate to horns in cattle and beards in wheat. We do not know exactly why these characters do not develop when they are in the heterozygote state. It is possible that in both these cases the absence of horns or beards may be due to the presence of some inhibiting factor, in which case the present category of latency would be a simple case of dominance of presence over absence. It seems probable, however, that these characters are simply unable to develop unless represented by two allelomorphs. The reasons for this assumption are rather too abstruse to be given here, for to make them clear would require a great deal of space, and they are also more or less speculative at the present time.[a]

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[a] See article by Shull in American Naturalist for July, 1909.

III.—LATENCY DUE TO HOMOZYGOSIS.

This group of facts might perhaps be better described as "patency due to heterozygosis." It includes those cases where a character is patent only in heterozygotes. The following discussion differs in some details from that given by Shull.

In Shull's bean crosses, mottled first-generation hybrids occurred between varieties neither of which was mottled, and subsequent investigation showed that the mottling only occurred in heterozygotes. Tschermak and Locke have both reported similar cases; also Professor Emerson, of the University of Nebraska. In all these cases the mottled beans produce progeny half of which is mottled and the other half not, thus giving a departure from the usual 3:1 ratio found in ordinary Mendelian characters.

The following explanation of all the above cases is here offered. The explanation will be given for mottled character, from which the explanation of the other cases may be easily inferred. The fact that in beans there are mottled varieties which breed true and which when crossed with the new type of mottled beans give ordinary Mendelian phenomena greatly strengthens the hypothesis here stated. Let us suppose that originally the mottling was due to two correlated characters; that is, to two characters which are always transmitted together. We may represent the determiner for this double character as M^a_c. The formula for those strains of mottled beans which reproduce true to type would then be $M^a_cM^a_c$. If we suppose that in some strains of these mottled beans the character *a* becomes latent or is lost, while in other strains the character *c* does likewise, while in still others both *a* and *c* become latent, we get three types of nonmottled beans, the formulæ for which are M^aM^a, M_cM_c, and MM. A cross between the first and second of these nonmottled types would give mottling of the character found by Shull. This cross would have the formula M^aM_c. In the next generation this would split up into one-fourth M^aM^a, one-half M^aM_c, and one-fourth M_cM_c, in which only the heterozygotes would be mottled, for it is only in them that we have both factors of the mottling. Either of the three types of nonmottled beans crossed with permanently mottled beans would give the ordinary Mendelian behavior of the mottled character in which in the second generation we should have three mottled to one nonmottled.

This same explanation is in accord with the facts in the case of the blue color in Andalusian fowls and the purple color in Imperial primroses. In the case of the blue Andalusians the blue may not be a reversion to a lost character, but may be, in a sense, a new character; but on the above explanation its presence in heterozygotes is assumed to be explicable on exactly the same basis as the presence of mottling in those beans in which it occurs only in heterozygotes.

IV.—LATENCY DUE TO HYPOSTASIS (MASKING).

Sometimes a character may be hidden by the presence of another character which simply obscures it. Thus, in the hair of most species of mammals there are both yellow and black pigments, each of which may be visible because of a certain other factor which causes them to develop more or less in different regions of the same hair. But in the absence of this controlling factor the black and yellow pigments develop in the same regions of the hair and the black thus obscures the yellow. Prof. T. H. Morgan found a case in the cross between the black rat and the Alexandrian rat, in which the black color was dominant over the gray color of the Alexandrian rat, presumably because the black color hid the other color characters.

Characters which are thus obscured by the presence of another character are said to be latent by hypostasis—that is, they are hypostatic to the obscuring character, while the latter is said to be epistatic to the obscured character. These convenient terms were suggested by Professor Bateson. In one of his crosses between black beans and yellow beans Shull obtained some seal-brown beans, and inferred that the seal-brown had been present in the black beans, but was there obscured by hypostasis.

V.—LATENCY DUE TO INHIBITION.

The category of latency due to inhibition is much like the last and was included by Shull, perhaps properly, with it. It seems possible, however, that it may deserve separate treatment. In the cases considered characters have been invisible simply because some other character present obscured them. There are cases, however, where the presence of one character seems to prevent the development of another character. For instance, Prof. V. L. Kellogg, of Leland Stanford Junior University, in crossing certain white and certain colored varieties of silkworms found the white to be dominant. Similar phenomena have been found by Bateson and Davenport in poultry, and the writer, in cooperation with Mr. Q. I. Simpson, has found the same in swine. Here the presence of the white character seems to prevent the color from developing rather than simply to obscure the color. Perhaps we might not be justified in treating this case as anything else than hypostasis. At any rate, the behavior in inheritance is exactly as in the case of hypostasis, as far as the ratios of the various types are concerned.

VI.—LATENCY DUE TO FLUCTUATION.

Some Mendelian characters are highly variable. Shull cites the case of certain leaf lobings which vary greatly under unfavorable conditions, and sometimes entirely fail to develop. When the plants in question were grown under favorable conditions, it was easy to demonstrate that leaf lobings are a good Mendelian character, but under certain unfavorable conditions the lobing disappears, thus confusing the Mendelian results. Kellogg found a similar case in silkworms. Certain strains of silkworms which produce salmon-colored cocoons when crossed with certain white strains gave results which showed clearly that the salmon color is a Mendelian character. But in some crosses the salmon color became extremely variable, extending all the way from almost pure white to very deep salmon color, thus somewhat obscuring the numerical relations of the colors in the second generation of the hybrid. In some of Correns's work with variegated plants he found a similar character. The variegation, although a good Mendelian character, varied with true green leaves as one extreme, and in some crosses this fact made the number of green leaves in the second generation larger than theory called for.

CORRELATION.

A good many cases have been found where two characters which, so far as appearance goes, are not physiologically related to each other seem always to be transmitted together, and the breeder frequently gets irregular results because of this coupling or correlation of characters. For instance, Tschermak found in Chinese oats that hull-less seed is correlated with long, many-flowered spikelets, and that these two characters were always transmitted together. In Price and Drinkard's work with tomatoes at the Virginia Agricultural Experiment Station they found what seems to be a case of this kind. In one of their crosses one of the parents had green foliage and two-celled fruit. The other parent had yellowish green foliage and many-celled fruit. The hybrid was like the first parent. In the second generation of this hybrid all the plants having green foliage had two-celled fruits, and all those having yellowish green foliage had many-celled fruits, thus indicating that the many-celled condition of the fruit is transmitted with the yellowish green leaf character, at least in this case. Hedrick and Booth, in their work with tomato hybrids, found that dwarf stature was correlated with dark-green rugous leaves, while standard stature was similarly correlated with lighter green smooth leaves.

Such cases sometimes give the breeder a good deal of difficulty. They are of special importance in relation to theories of heredity, and should always be carefully noted and reported.

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 166.
B. T. GALLOWAY, *Chief of Bureau.*

THE MISTLETOE PEST IN THE SOUTHWEST.

BY

WILLIAM L. BRAY,
SPECIAL AGENT, INVESTIGATIONS IN FOREST PATHOLOGY

ISSUED FEBRUARY 2, 1910.

23494 91
13 1 36

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

BUREAU OF PLANT INDUSTRY.

Chief of Bureau, BEVERLY T. GALLOWAY.
Assistant Chief of Bureau, ALBERT F. WOODS.
Editor, J. E. ROCKWELL.
Chief Clerk, JAMES E. JONES.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 24, 1909.

Sir: I have the honor to transmit herewith a paper entitled "The Mistletoe Pest in the Southwest," by Prof. William L. Bray, formerly a special agent in the Office of Investigations in Forest Pathology.

The paper embodies the results of several years of investigation of the various phases of the mistletoe pest and an account of the methods of combating it that are known at present. The subject of control of the mistletoe pest is still under investigation in this Bureau. This paper, however, marks the completion of Professor Bray's work on the subject. I recommend that it be published as Bulletin No. 166 of the special series of this Bureau.

Respectfully,

A. F. Woods,
Acting Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE MISTLETOE PEST IN THE SOUTHWEST.

INTRODUCTION.

The name "mistletoe" was long ago applied to the mysterious parasitic European shrub to which, centuries later, Linnæus gave the technical name *Viscum album*, by which name it is at present distinguished from other related species also called mistletoe. These other more or less closely related species have been discovered from time to time in almost all parts of the world—certainly in most of the warm countries—until at the present time a large kinship circle or family of mistletoes is known, embracing more than 600 species. In the course of botanical explorations in the Western Hemisphere numerous representatives of this family were found, and among them one which so closely resembled the original mistletoe that it was given the generic name Viscum, with the specific designation flavescens; indeed, one early botanical explorer, Thomas Walter, called specimens found in the Carolinas *Viscum album*, under the impression that they were identical with the European plant. Later, the pioneer botanist, Nuttall, suggested that the American plant differed from the European one widely enough to deserve separate generic distinction, and so proposed the name *Phoradendron* (tree thief). The name then became *Phoradendron flavescens*. Interestingly enough, the specimen upon which this name was based was from Texas.

In spite of the fact that there are some scores of species of mistletoe in the Americas (including the West Indies), this *Phoradendron flavescens* enjoys the distinction of being *the* American mistletoe, and has been accepted in this country in lieu of the genuine mistletoe of Europe and invested with much of its traditional and historical setting.

DISTRIBUTION AND HARMFUL OCCURRENCE OF MISTLETOE.

The American mistletoe is a leafy, green, parasitic shrub, commonly found growing upon various species of broad-leaved trees throughout the Southern States and extending in more or less modified forms across Texas, southern New Mexico, and Arizona to southern California, and thence northward in the coast region to

Oregon and Washington. Eastward its northern limit is in New Jersey, southern Pennsylvania, southern Ohio, Indiana, Illinois, Missouri, and eastern Oklahoma. Speaking generally, mistletoe is held in rather high regard everywhere because of its inherently interesting mode of life, because of the traditional and historical atmosphere which invests the original mistletoe of Europe, and because of its desirability, for the above and other reasons, as a decorative Christmas shrub. The fact that it is a parasite implies a possible injury to the tree upon which it grows, but, again speaking generally, the injury is regarded as relatively slight and more than offset by the feeling of regard for the parasite. Among people who see it rarely, and, especially among those living in northern cities who purchase small sprigs or bunches of it at a good price for Christmas decoration, the idea of mistletoe being a harmful parasite upon trees is quite lost sight of. Nevertheless, there are localities in which mistletoe becomes so abundant upon trees and so harmful to them as to make the control of it or its extermination a serious practical question.

This is notably the case in parts of Texas. Between the ninety-sixth and ninety-seventh meridians in Texas is a belt of country in which mistletoe is a serious parasite in many localities. The area most harmfully infected would be comprised in a circle of 100 miles, more or less, in radius, having its center at Austin. The north-south extension of this area is really greater than its east-west dimensions, for to the eastward one passes presently into the more humid and more heavily timbered country, and westward the available hosts for the parasite become fewer.

The climatic conditions of this area have a more or less direct bearing upon the question. Between the ninety-sixth and ninety-seventh meridians in Texas and Oklahoma lies a zone of transition from the humid climate of the Gulf States to the arid climate of the Southwest. The heavy forest growth of the South does not enter this belt, except as it follows the moist soils of river and creek bottoms, and even in these favorable situations the luxuriant growth becomes checked by the decreasing rainfall and drier atmosphere. Upland tree growth is stunted; the trees occur more sparsely, are broader of crown, less tall, and more frequently of imperfect growth. The trees bear evidence of a struggle against unfavorable conditions. In this region it becomes a difficult matter to secure umbrageous trees for shading and beautifying streets and parks and private grounds. Not many native species are suitable for these purposes. Very little has been done toward the solution of the whole question of selection, planting, and care of shade trees.

In spite of the less inviting conditions for forest growth, mistletoe appears to flourish better in this belt than elsewhere; at least, it is relatively more abundant than it is eastward. It is a curious fact, whose explanation is not very obvious, that mistletoe is more varied in form and relatively more abundant in the arid districts of the Southwest (e. g., portions of New Mexico and southern California) than it is in the Gulf States east of the ninety-sixth meridian. It is not that the growth of mistletoe as a shrub is more vigorous than in the eastern belt; as a matter of fact, in the more humid climate it makes a most luxuriant and symmetrical growth, but fewer of the trees relatively are infected and these evidently in more restricted localities.[a] In river or creek bottoms or in swamps one sees the taller trees with bunches of mistletoe far up on the remote branches. In middle Texas, on the contrary, mistletoe is by no means confined to bottom-land trees, but it infests those of upland prairies also. Stunted native growths and transplanted trees are especially apt to be infected, and not merely by isolated bunches of mistletoe on remote branches, but throughout the tree on old as well as young branches, and not infrequently upon the main trunk itself, so that the whole tree is infected, weakened and disfigured, and finally killed. (Pl. I, fig. 1.) Thus it comes about that just in the region where trees in perfection are especially difficult to find they are more than elsewhere subject to harmful infection by this parasite. The explanation may be suggested that mistletoe, like a good many other plants of arid situations, requires much sunlight for its best growth and especially for the development of flowers, and thereby of numerous and vigorous seeds, and is at a disadvantage in competing with the heavy shade-casting foliage of forests in humid climates. The necessity for light might explain why in bottom-land forests of the East mistletoe is confined to the highest branches of the tallest trees (as shown by observations made in the case of bottom-land timber in parts of Arkansas, southeastern Oklahoma, and northeastern Texas), and how with increasing intensity of sunlight and the more meager foliage and open stand of trees incident to the drier climate of the Southwest mistletoe is enabled to spread over the entire tree.

That more arid environmental conditions have acted in the nature of a stimulus to mistletoe in its growth and reproduction may be alleged from the fact that in the arid Southwest there is much more variation in the habit of the plant than there is in the Atlantic and Gulf forest regions. Thus between middle Texas and southern California there are several distinct types or varieties of *Phoradendron flavescens* (*macrophyllum*, *villosum*, *orbiculatum*, and *pubescens*), besides several more distinct species, notably *Phoradendron californi-*

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[a] Exceptions to this statement are not unusual. Thus, at Houston, Tex., at various points in Louisiana, and also in some localities in Mississippi and Tennessee, mistletoe has been reported as harmfully abundant in isolated trees or clumps of trees in dooryards and parks.

cum, which infests many species of desert trees and shrubs, and *Phoradendron bolleanum* and *P. juniperum,* which last two are especially noteworthy as being parasitic upon coniferous trees, especially desert junipers.

BIOLOGY AND LIFE HISTORY.

A brief account of the life history and of the habits of nutrition of mistletoe will assist in making clear the reason for its harmfulness to trees. The plant is a parasite. It fastens itself upon its host, the tree, penetrates its tissues, and draws nourishment from it, deforming it and sapping its vitality. Yet the mistletoe is a green, leafy plant; that is, it possesses the pigment chlorophyll, which gives the green color to normal vegetation. Some of the tropical species of mistletoe bear leaves as large as those of an American elm. The presence of green leaves indicates that the mistletoe has the power, which independent green plants everywhere possess, of constructing organic foodstuffs, such as starch, out of inorganic compounds (carbon dioxid and water), utilizing sunlight as the source of energy in the process. It is therefore only partly a parasite so far as dependence upon a host for food is concerned, but apparently none the less harmful on that account. It secures from its host apparently only what the normal, shrubby plant derives from the soil, namely, water and certain necessary mineral constituents. Imagine a grapevine or trumpet creeper, while retaining its foliage, to sever connection with the soil and to thrust root-like outgrowths into the body of the tree to which it clings, in order to absorb from the tree what before it absorbed from the soil. This would represent the relation which mistletoe sustains to its host.

In this connection it is instructive to observe that the mistletoe family, viewed as a whole, shows a progressive development of parasitism. Thus at one end of the series stands the Australian genus Nuytsia, whose single species is a nonparasitic tree. At the opposite extreme is the degenerate, absolute parasite *Phrygilanthus aphyllus,* parasitic upon a cactus of the genus Cereus in Chile. This plant is said to possess neither cotyledons nor foliage leaves, nor does it develop the vigorous shrubby habit characteristic of mistletoes generally. The more familiar mistletoes are sometimes called "half parasites," but they also show great variation in habit from the very broad-leaved forms above mentioned down to those which are yellow-green and quite leafless; e. g., *Phoradendron juniperum* and *Arceuthobium pusillum,* the latter of which barely emerges from its host.

In the general sequence of events the life history of mistletoe is just like that of any flowering woody plant; for example, the hackberry, upon which it preys. It bears flowers; in due time the berries follow, each with its inclosed seed; the berries are deposited by birds or beaten down by rains upon the branches, where under favorable conditions the seeds germinate, and if the seedling becomes established upon the branch it grows again to the age of producing flowers and seed, and so on from generation to generation. Of course the mistletoe seed is more limited than the hackberry in its choice of a substratum upon which to grow, since the only situation in which it has any prospect of developing a plant is upon some part of a living tree.

DEVELOPMENT OF FLOWERS AND FRUIT.

The flowers of the American mistletoe are minute and inconspicuous, although in some tropical mistletoes they are relatively large and showy. The flowering season in Texas falls usually in December, which is approximately the date of flowering for the species throughout its range. The plant is diœcious; that is, any one individual is wholly male or wholly female. Manifestly some plants never produce berries. This separateness of pollen-producing and ovule-producing plants makes it a matter of importance whether female and male plants grow in close proximity and whether there are any special means by which pollination is effected. Several of the conspicuous-flowered tropical mistletoes are regularly pollinated by insects. It is claimed also that the European mistletoe (*Viscum album*) is pollinated by insects, but so far as has been determined the American mistletoe apparently depends upon the wind to carry its pollen.

After the flowering period and pollination, the development of seed and berry goes forward very slowly. With the approach of the following winter the berry begins to enlarge and by December the seeds are ripe and the berries pulpy and white. Thus it happens that the flowering season of this year coincides with the ripening of fruits begun a year ago.

DISTRIBUTION OF SEED BY BIRDS AND OTHERWISE.

The seed when ripe is inclosed in a clear, sticky pulp covered by a tough, semitransparent skin, the whole constituting the mistletoe berry.[a] This pulp appears to be in some degree an object of food to certain birds, notably to mocking birds, cedar birds or waxwings, and to robins in Texas,[b] and the seeds are distributed in considerable numbers by these birds either in their excrement or by being wiped from the beak against a branch in the birds' efforts to remove the adhesive pulp. In either case the pulp still remaining about the seed causes it to stick to the branch and by drying to become firmly pasted there. It is the conclusion of most observers that the mocking bird is the chief distributer of mistletoe seed, but perhaps the cedar birds actually distribute more, for in March and April these birds appear in flocks of hundreds in search of berry mast—especially hackberries—and during the brief visits of a few days or a week or two all the berry-laden trees are visited repeatedly until the berries are gone. During these flights, mistletoe berries are also eaten, though probably not much noticed until the hackberry crop is exhausted. Robins also are reported to be common distributers of mistletoe seed. In the vicinity of Austin large flocks of robins spend the winter, or part of it, in the cedar brakes, where they feed largely on cedar mast; but at times they appear in numbers about farmyards and in towns, feeding upon hackberries, and during these visits also upon mistletoe berries.

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[a] In the case of the European mistletoe the sticky pulp of the berry is utilized in the preparation of bird lime.

[b] Doubtless most berry-eating birds feed more or less upon mistletoe berries, according to the abundance or scarcity of other, choicer kinds. Thus in Bulletin No. 120 of the University of Texas on the American mistletoe, page 7, Mr. York reports that sparrows and cardinals are the principal birds, next to the mocking birds, which feed upon mistletoe berries.

Mistletoe is, however, not wholly dependent upon birds for the distribution of its seeds, for as the spring advances and the berries grow softer they fall away easily, becoming crushed and adhering to the branch below. Especially are they beaten off in heavy downpours of rain and washed against the branches, where they are left adhering in favorable situations for germination. The character of infection of certain cedar elm trees illustrates very plainly this method of infection. Pendent branches become laden with bunches of mistletoe from base to tip, showing how the seeds were washed down the branch during a heavy rainfall.

STRUCTURE AND VITALITY OF THE SEED.

Of course, mistletoe seeds become planted in the ways just described in all sorts of places and in favorable weather are induced to germinate in almost any situation- upon branches, upon the main trunk, upon leaves, dead twigs, fences, and even upon mistletoe itself—but the only situation in which there is any prospect of this germination resulting in the establishment of a mistletoe plant is, as previously stated, upon the living branch or trunk of a tree, and only then where the bark is thin or cleft, or otherwise in a condition to permit the penetration of the root axis or sinker of the seedling. In any event, the bark or epidermis of a tree would seem to be barren soil, since it dries so quickly. This is particularly true in central Texas and westward, where the atmosphere is habitually dry. The seeds have need to be strongly drought resistant, and this quality they seem to possess in a marked degree.

They begin to be distributed upon branches in December and January, but favorable conditions for germination are not likely to occur before March, and perhaps not before April or May, depending upon the temperature, and when this is sufficiently high upon the appearance of a period of rainy, humid weather. Whether the seeds placed upon branches in midwinter remain capable of germination as late as April or May is not known, but of course many berries remain to be distributed as late as May. If it be true that birds eat mistletoe berries only when other choicer kinds are no longer available, then the chief season of distribution would about coincide with the more favorable conditions for germination.

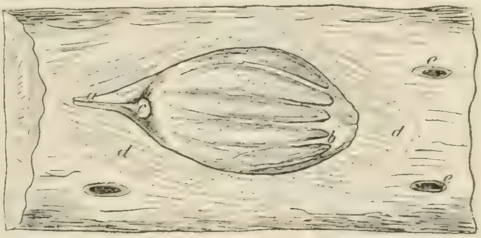

FIG. 1.—A seed of mistletoe pasted on a branch by berry pulp and ready to germinate: *a*, Beak of seed coat; *b*, fibrous coat of seed; *c*, root tip of embryo; *d*, *d*, berry pulp; *e*, *e*, lenticels on branch. (All very much enlarged.)

The pulpy covering in which seeds are embedded upon a branch is a protection to them against extreme drying out and doubtless useful also in absorbing water before germination, thus allowing the seed to lie in a moist, slimy matrix. (See fig. 1.) The seed structure proper is also adapted to the arid conditions upon a branch. The seed is invested in a fibrous coat (endocarp) quite unlike the customary hard shell of berry seeds, which is peculiarly active in absorbing water and transmitting it to the living parts within. The peculiar thickening of the walls of the cells in this fibrous coat suggests the water-absorbing tracheid cells of sphagnum moss and of the velamen in the air roots of certain orchids, both of which types are noteworthy because of their water-absorbing properties.

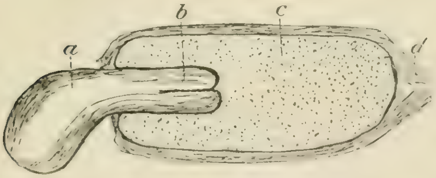

FIG. 2.—Sectional view of a germinating mistletoe seed: *a*, Embryo, showing knob-like enlargement of root end; *b*, cotyledons of embryo; *c*, endosperm or food supply; *d*, fibrous seed coat.

Within the fibrous coat lies a body of food material or endosperm in which the minute embryo lies embedded, except for its slightly protruding root tip (fig. 2). Both embryo and endosperm retain chlorophyll pigment throughout the dormant period, but previous to germination the green color becomes intensified and the presence of a gas (oxygen?) in the interspaces shows that the seed is already a carbon-assimilating body, able to proceed with its development within the moment of arrival of favorable conditions or of lying dormant and uninjured with the return of arid conditions. It appears capable of repeating this behavior of alternate activity and dormancy throughout the germination period and until the seedling is fully established, and therefore less influenced by sudden fluctuations of moisture and dryness. In short, the seed in its germination phase is a well-adapted drought plant or xerophyte.

GERMINATION AND ESTABLISHMENT OF THE SEEDLING.

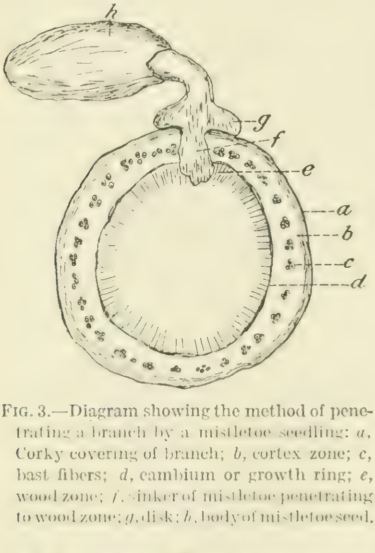

FIG. 3.—Diagram showing the method of penetrating a branch by a mistletoe seedling: *a*, Corky covering of branch; *b*, cortex zone; *c*, bast fibers; *d*, cambium or growth ring; *e*, wood zone; *f*, sinker of mistletoe penetrating to wood zone; *g*, disk; *h*, body of mistletoe seed.

The first apparent movement in germination consists in the elongation of the axis (hypocotyl) of the embryo, whereby the root tip is thrust beyond the beak of the seed jacket, thus becoming directly exposed to the air and sunlight. Upon becoming exposed the axis bends so as to bring the blunt end of it into contact with the underlying branch. This prompt bending in its growth appears to indicate a sensitiveness of the tip toward the branch, but it has been shown that it is on account of its sensitiveness to light that the axis bends, and the bending has for its object the avoidance of too intense illumination. This, however, results in bringing the root tip of the embryo against the branch. The root end of the embryo is blunt or even knob-shaped while still within the seed jacket, and as it emerges and turns toward the branch the end further enlarges until it becomes prominently knob-formed even before it comes into contact with any underlying object (fig. 2). When, however, it touches the branch, the knob becomes broader and is flattened on the contact side, as when a plastic object is pressed firmly against a hard surface. Thus it behaves like an adhering disk or sucker, such as one observes in the Boston ivy, where the tips of the clinging tendrils flatten against the wall. At the center of the flattened disk the cells continue to push forward, with the result that a point of tissue, the primary sinker, bores its way, or, perhaps more accurately, dissolves its way, into the tissues of the branch (fig. 3), for the cells of this puncturing point are able to secrete a substance (enzyme) capable of dissolving the walls of cells lying in its path. Thus it really dissolves and absorbs the tissue of the host. This primary sinker pushes downward through the soft bark zone (cortex, phloem, and cambium) until it reaches the younger wood cells. Meanwhile an axial strand of cells in the primary sinker becomes differentiated into water-transporting tracheids, of which those formed in the wood zone of the host become applied to the water-carrying cells of the host, thus establishing an efficient means of conducting water and mineral nutrients from the host into the parasite. The mistletoe seedling is now virtually a tiny bud graft (fig. 3).

Having thus established its connection with the source of some of its food supply, the upper end of the hypocotyl with the minute cotyledons gradually withdraws from the inclosing and partly digested endosperm, and becoming erect the cotyledons slowly expand as the first pair of green leaves. Perhaps this is as far as development goes during the first season. In some species of mistletoe the cotyledons remain covered by the seed jacket and endosperm (if there is any) during all of the first season. Apparently the progress of development at this period depends upon weather conditions. In a dry climate these are apt to be such as to interrupt repeatedly the progress of germination and of becoming established. Existence becomes largely a question of endurance during this period, and it is probable that in a season of unusual warmth and humidity the seedling progresses in its development farther than merely to expand the cotyledous; whereas, in an unfavorable season, if the seedling survives at all it may approach the winter with germination, in the popular sense, still incomplete. This seems to be a reasonable interpretation of facts and conditions thus far observed in the field, and it points with renewed emphasis to the peculiarly resistant qualities of the mistletoe at this period of its existence. In spite of these qualities, however, the great majority of mistletoe seedlings perish, or the seeds never germinate at all in the face of such extreme arid conditions as frequently prevail.

It should be noted that the mistletoe in establishing itself as previously described, with its primary sinker in contact with the wood cells, has the problem of adjusting itself to the season's growth in thickness. This it does by maintaining a zone of embryonic tissue in the sinker corresponding to the cambium zone of the host.

Some time after the seedling has established itself as described, probably not until the second season's growth, there arise from the primary sinker in the zone of soft bark, or cortex, lateral outgrowths called cortical roots, or cortical haustoria, which spread along and around the host stem in this cortex zone, extending farther and farther from the original point of penetration (fig. 4). At intervals from the side of the cortical roots nearest the wood zone more sinkers arise and penetrate along the line of least resistance (medullary rays) into the wood, where they develop a connection with the water-carrying vessels as the primary sinker did. These cortical roots persist and increase in thickness; indeed, it appears to be the thickening of these at their junction with the parent axis which gives the enlarging mistletoe bush its strongly buttressed attachment to the branch (fig. 4). The presence of these persistent cortical roots interrupts the formation of host tissue exterior to them, and thus they come to lie more or less exposed along the surface of the branch. At these exposed places (possibly also from the younger cortical roots still within the cortex zone) adventitious buds are developed which may give rise to new mistletoe shoots. (See figs. 5 and 6.) They do this in considerable numbers if from any cause the original mistletoe plant is injured, or especially if it be broken off, as is most frequently done when the effort is made to rid a tree of the parasite. In this way the cortical roots are stimulated to further growth and to giving rise to repeated crops of mistletoe shoots. Scraping off the old plants stimulates the development of more adventitious buds and thus tends to enlarge the area of infection.

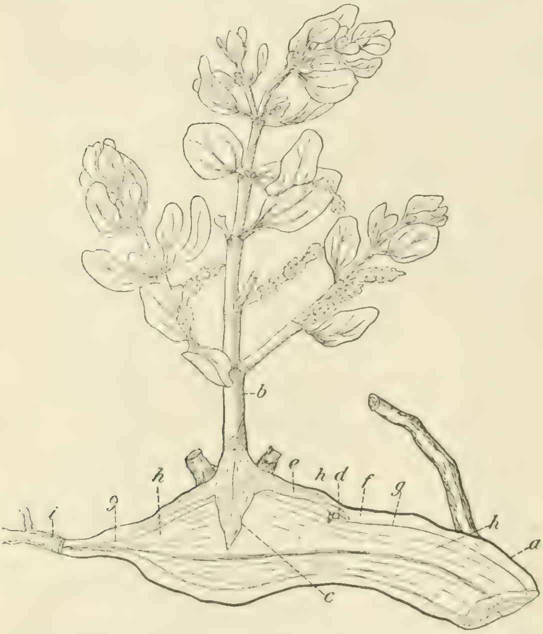

FIG. 4.—Sectional view, partly diagrammatic, of a branch infected with mistletoe, showing the relation between parasite and host: *a*, Branch of host tree; *b*, mistletoe; *c*, primary sinker; *d*, sinker from cortical root *e*; *f*, cortex or soft bark; *g*, cambium or growth ring; *h*, wood of branch. The starving and dwarfing of the branch beyond the mistletoe is shown at *i*.

It has been observed that in some trees, or at least in some situations on the branch, there is no considerable spread of cortical roots and no development of shoots from adventitious buds. Thus, in the case of the water oak one may find huge bushes of mistletoe a yard in diameter on branches eight or ten years old with not a single indication of the spread of the infection along the branch. This may be observed also in the mesquite and doubtless in any other tree where the primary mistletoe plant started on a very young branch and has developed unharmed. (See fig. 5.) In the course of time, however, the original plant is destroyed by some agency or other, but the cortical roots persist and thenceforth develop secondary shoots from adventitious buds. In this way may be explained the characteristic occurrence of mistletoe on old branches and even on trunks, as shown not infrequently on mesquite and very commonly on hackberry. The cortical haustoria have persisted for years, in many cases producing an unsightly deformity of the branch or trunk (fig. 7). There is an obvious similarity between this behavior of mistletoe and that of certain noxious weeds, such as Johnson grass, where from an original plant underground rootstocks spread in all directions, sending down more roots into the soil and sending up plant after plant into the air until a wide area is beset by it; also in the further respect that merely cutting off the tops only serves to stimulate the underground parts to greater activity in spreading and breaking out in new places.

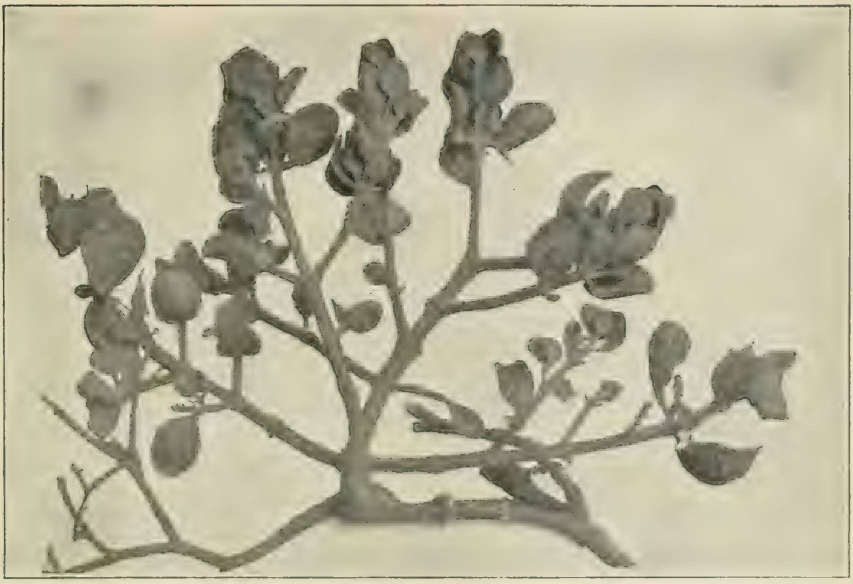

FIG. 5.—Mistletoe on a branch of a cedar elm tree, showing the starved end of the branch and how mistletoe comes to be terminal on a branch.

RATE OF GROWTH.

During the period in which the parasite is becoming established the rate of development, as already shown, is extremely slow. During the whole of the first season the mistletoe plant may not grow more than a quarter or half inch in length. After becoming thoroughly established, however, growth is relatively rapid, depending, as does the host also, upon the character of the season. The shoots from adventitious buds have been observed to grow to the length of 1 to 6 inches in a single season following the spring pruning of the previously developed crop of shoots. In the case of water oaks growing in wet bottom-land soil, bunches of mistletoe have been observed to develop in six to eight years into a shrub having a spread of nearly 3 feet and to be more than an inch in diameter just above the buttressed point of attachment to the slender branch of the host (Pl. II, fig. 1). The rate of growth varies with the host, being much slower in the cases of the mesquite and the osage orange. The location of the host with respect to moist or dry soils naturally also affects the rate of growth of the parasite.

LONGEVITY.

The parts of mistletoe embedded in the tissues of its host appear to have no fixed limit to continued existence except the death of its host. Specific data in this connection are not at hand for the American mistletoe, but in the case of European mistletoe Tubeuf states that often sinkers are found extending through sixty to seventy annual rings of growth. There are many cases in Texas where mistletoe has been repeatedly broken from large branches during the past twenty or twenty-five years. In cases where the trunk of the mesquite and the hackberry are notably deformed it is probable that the infection is nearly as old as the host.

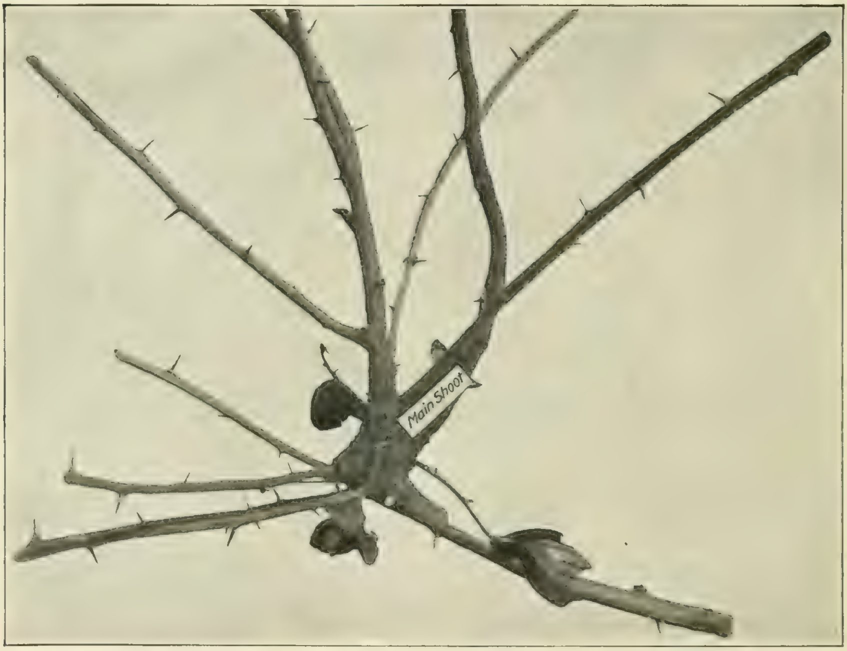

FIG. 6.—A branch of an Osage orange tree infected with mistletoe, showing deformity and multiplication of branches at the point of infection.

With regard to the aerial part it would appear that any single bush would scarcely survive more than eight or ten years, chiefly because of the likelihood of its being broken off by storms, or being killed by freezing, or otherwise being mechanically destroyed. It is maintained that in extreme cold weather mistletoe has been largely killed out over large areas; for example, in the unprecedented cold wave of February, 1900. Its own bulkiness and brittleness would seem to operate toward the self-destruction of the mistletoe bush. In the case of infection upon the mesquite, spoken of elsewhere, the parasite so injures the branch upon which it sits as to kill the branch and thereby destroy itself. Usually, however, accident to the aerial part of the parasite merely results in stimulating the development of adventitious buds—and thereby in multiplying the number of mistletoe shoots upon a gradually widening area of infection.

EFFECT UPON THE HOST.

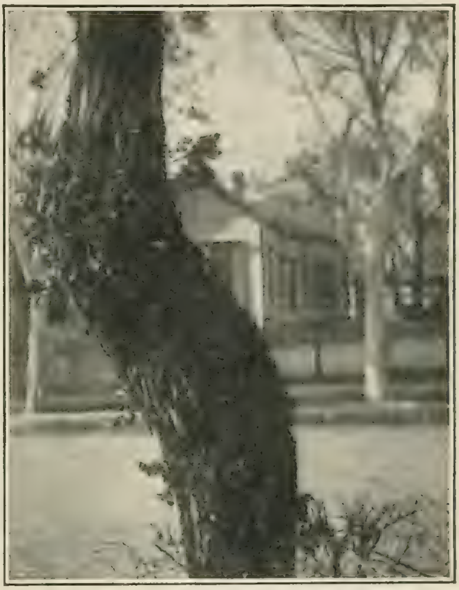

Fig. 7.—The trunk of a mesquite tree at Waco, Tex., deformed by long-standing mistletoe infection.

Perhaps in the majority of cases the original point of infection is upon a small, remote branch. The habit of the mistletoe is of course to draw sustenance from the branch and in increasing quantity as the parasite increases in size. The immediate result is to starve that portion of the branch lying beyond the point of infection, and while this part may persist for some years alive without noticeable growth, in the end it dies, and the mistletoe thus comes to occupy the end of the branch. (See fig. 5.) This habit is particularly well shown in the water oak, where very large clusters 2 to 3 feet in diameter swing from the end of a long slender branch not more than an inch in diameter next the swollen point of junction of the host and parasite (Pl. II, fig. 1). At the point of attachment also the branch is stimulated to excessive growth, which gives rise to deformities of varying shapes on different host species. In the water oak just mentioned both branch and mistletoe are enlarged like a clumsy piece of welding. Frequently, as in the Osage orange, the branch is stimulated to an excessive formation of shoots, forming a sort of witches' broom. (See fig. 6 and Pl. II, fig. 2.) Large branches, and not infrequently the main trunks of trees, may be greatly deformed by the mistletoe. This happens where infection occurred when the tree was young and has persisted to misshape all its subsequent growth. (See fig. 7.) On the other hand, very many trees are infected for years without showing any noteworthy deformity, and, as a matter of fact, this item is not one of serious economic importance.

Mistletoe not only causes mechanical injury, but it saps the vitality of the branch and when sufficiently abundant often the whole tree; and in the case of the hackberry, especially, often results in the death of the entire tree. About Austin considerable numbers of hackberry trees have been and are being destroyed in this way. At Bryan, Tex., this is true of water oaks. It has been supposed that perhaps the mistletoe merely supplants the end of the branch which was starved by its presence, and that while it receives what the branch would otherwise receive, it in turn contributes to the tree by its assimilating activity what the displaced branch would have done. This seems never to be the case at any time, and it is certain that when the majority of branches become so supplanted by the mistletoe, the tree dies, showing the parasite to be always a drain upon its host. One of the curious results of infection has been often observed, especially in the Uvalde region, where bunches of mistletoe on remote branches of the mesquite, becoming large, so injure the branch that it decays beneath the mistletoe, which thus itself is starved and killed and presently falls away, leaving the branch free from infection. This is probably due to decay induced by the starving of the branch beyond the original point of infection.

THE POINT OF ATTACK.

In the process of establishing itself upon the host, the critical point for the mistletoe seedling is to penetrate the covering of the branch so as to reach the food-supplying cells of the cortex and wood. The sinker can exert pressure and is doubtless able to force an entrance through fissures or through natural openings, such as lenticels, and between bud scales, as shown by Cannon.[a]

The growing tip of the sinker has been shown to secrete an enzyme capable of dissolving the walls of certain cells lying in its path. Whether heavily cutinized walls or the walls of dead cork cells can be dissolved by this secretion has not been fully determined. Cork and bark certainly offer much more resistance to the forward growth of the sinker than cellulose walls do, and it is quite unlikely that a heavy layer of these could ever be penetrated by a mistletoe sinker. When infection begins on the old parts of a tree it must be at some fissure or thin place in the bark. Naturally the younger branches, and especially twigs of last season's growth, present the most vulnerable points of attack, and as therefore would be expected, infection begins in the majority of cases on the remote young branches, where the protective covering is thinner and the lenticels (breathing pores) still numerous. Here also the buds offer a point of attack. Cannon states that in the case of a mesquite branch he has seen as many as a half dozen successive buds bearing mistletoe. The hypocotyl of the seedling pushes its way between bud scales to the more easily penetrated tissue at their base. Cannon also holds that even on the youngest branches the penetration of a sinker is conditioned upon its finding a lenticel or inserting itself between bud scales; but in view of the abundance and varying aspects of infection it seems necessary to ascribe a more active rôle to the sinker than that of mechanically pushing its way through openings and crevices, and that a less haphazard mode of infection prevails. However, no actual proof is at hand that the sinker can secrete an enzyme that will dissolve cutinized or cork cell walls.

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[a] Cannon, W. A. Observations on the Germination of Phoradendron villosum and P. californicum. Bulletin, Torrey Botanical Club, vol. 31, pp. 435–443. 1904.

The location of the point of infection upon a tree appears also to have some relation to the perching habits of the birds which eat the berries. This idea is held notably in the case of mocking birds. Large areas of mesquite-covered country to the westward of San Antonio show a predominance of cases where a single plant of mistletoe occupies the most conspicuous spot upon the tree, namely, near the apex of the farthest spreading top branch. This appears to coincide with the choice of perching places by the bird in its flight from tree to tree. The habits of cedar birds in their repeated short flights and perching during their spring visits in search of berry mast are also such as to afford the largest likelihood of mistletoe seed being deposited on the youngest branches.

TREES MOST SUSCEPTIBLE TO MISTLETOE INFECTION.

It is a question whether any tree is wholly immune to attacks from mistletoe. Certainly there is reason to believe that mistletoe could be induced to grow upon any living woody plant. But from the actual status of infection in any community where mistletoe grows there are some trees which are practically immune. One of the curious things about the matter is the prevalence of infection upon different species in different localities. Thus, in the vicinity of Austin, the hackberry and the cedar elm are the trees most frequently and heavily infected. The sycamore, though common in central Texas, both native and cultivated, has not been reported to have mistletoe in any case; whereas in the river bottoms of Arkansas and southeastern Oklahoma it is one of the most commonly infected trees. Broad-leaved elms are practically immune in the Austin region, but at Muskogee, Okla., and northward such elms are as thoroughly beset with mistletoe as the cedar elm is at Austin. At San Antonio and southwestward the mesquite is the chief mistletoe host. At Bryan, which lies farther within the humid belt, the water oak is the most infected species. At Marble Falls, about equally distant but westward from Austin, the live oak and mesquite are reported as the main hosts. So in the osage orange belt of northeastern Texas—notably from Greenville to Paris—that species (*Toxylon pomiferum*) is more infected than others. In the vicinity of Calvert, Tex., the blackjack oak (*Quercus marilandica*) is abundantly infected, but other species not notably so. In reality, the species most infected in all these instances are either the most abundant or else the most prominent in certain situations; for example, along water courses or about farmyards and in towns. Even so, it is not clear why, for instance, the blackjack oak, which is the prevailing host in certain districts, should be comparatively immune in another district where mistletoe is even more common. Extending the range of observation, it is found that the dominant host for *Phoradendron flavescens* and its different forms varies with the geographical location, as follows: In the South, the water oak and other red or black oaks of wet soils, gums, elms, and sycamores; in the Santa Clara Valley, California, especially on deciduous oaks (the prevailing form here being *Phoradendron flavescens villosum*); in southern California *Phoradendron flavescens macrophyllum* on the poplar, willow, ash, and others; at Tucson, Ariz., *Phoradendron flavescens macrophyllum* on the poplar (cottonwood), ash, and black locust, and *Phoradendron flavescens villosum* on oaks and the hackberry.

LIST OF HOSTS OF THE MISTLETOE IN TEXAS.

Pecan (*Hicoria pecan* (Marsh.) Britton).
Hickory (*Hicoria* species). (At Columbus, Tex.)
Post oak (*Quercus minor* (Marsh.) Sargent).
Bur oak (*Quercus macrocarpa* Michx.).
Texan oak (*Quercus texana* Buckl.).
Water oak (*Quercus nigra* L.).
Willow oak (*Quercus phellos* L.).
Blackjack (*Quercus marilandica* Muench.).
Live oak (*Quercus virginiana* Mill.): (Marble Falls and Comanche, Tex.; not noted at Austin).
Cedar elm (*Ulmus crassifolia* Nutt.).
White elm or American elm (*Ulmus americana* L.).
Hackberry or Sugarberry (*Celtis mississippiensis* Bosc., and varieties).
Osage orange (*Toxylon pomiferum* Raf.).
Paper mulberry (*Papyrus papyrifera* (L.) Kuntze).
Sassafras (*Sassafras sassafras* (L.) Karsten).
Sweet gum (*Liquidambar styraciflua* L.).
Apple (cultivated varieties).
Pear (cultivated varieties).
Cherry (*Prunus* species, wild).

Thorn (*Crataegus* species).
Roemer's acacia (*Acacia roemeriana* Scheele).
Mesquite (*Prosopsis juliflora glandulosa* (Torr.) Sargent).
Water locust (*Gleditsia aquatica* Marsh.).
Honey locust (*Gleditsia triacanthos* L.).
Prickly ash (*Xanthoxylum clava-herculis* L.).
China (*Melia azedarach* L.).
Wild China (*Sapindus marginatus* Willd.).
Black gum (*Nyssa sylvatica* Marsh.).
Persimmon (*Diospyros virginiana* L.).
Water ash (*Fraxinus caroliniana* Miller).
Berlandier ash (*Fraxinus berlandieriana* A. de C.).

To this list must be added the interesting case of a climbing vine (*Tecoma radicans* (L.) Juss.) as a host plant observed at Bryan, Tex. No doubt this list might be very much extended by a careful survey throughout the State.

FREEDOM OF INTERCHANGE OF HOSTS.

The question arises as to whether parasitism in the mistletoe is in any considerable degree exclusive, i. e., whether by continued growth on a given host species it becomes less capable of infecting a different species. A survey of the field outside of the *Phoradendron flavescens* circle shows that this sort of thing is possible, at least within certain limits. Thus there is a group of species brought together under the generic name Arceuthobium, all of them being parasitic exclusively upon coniferous trees, and some of them upon one species exclusively. More to the point is the case of the European mistletoe (*Viscum album*) and its circle of related forms. Tubeuf[a] distinguishes three forms: (1) That infecting broad-leaved trees, Laubholz mistel; (2) one which infects fir trees (*Abies pectinata* and *A. cephalonica*), Tannen mistel; and (3) the form parasitic on pines (*Pinus sylvestris* and *P. laricio*), Föhren mistel. Tubeuf maintains that none of these three forms is capable of infecting hosts of the others, and has sustained his position by abundant observations in the forest and by inoculation experiments.

It should be noted here that in the case just cited the form which is parasitic upon broad-leaved trees has numerous hosts—twenty-two host species are listed for a single park forest—and that a good deal of freedom of interchange among hosts is possible. It seems likely, therefore, that the central Texas form of mistletoe may be more or less easily established upon all of the hosts (at least in any given district) by seed carried from the mistletoe growing upon any one of them, and that the immunity which some trees seem to have is due to the mechanical hindrance exercised by the bark or cork, or the simple epidermis, to penetration by the primary sinker, or possibly to the density of shade, as in the case of the China tree (*Melia azedarach*).[b] This relative immunity of species becomes, however, a matter of practical importance as indicating one of the qualities (resistance to mistletoe) that will influence the choice of trees for planting for shade or wind-break or ornament.

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[a] C. Tubeuf. Die Mistel (Viscum album) Pflanzenpathologische Wandtafeln no. 1 (text), 1906, and more recently in Naturwissenschaftliche Zeitschrift für Land und Forstwirtschaft, no. 5, vol. 7, 1907.

Further, it should be noted that the mistletoe varies considerably in habit on different hosts, and especially where the hosts occupy notably different situations as to soil and climate, being in this respect plastic, like the majority of plants capable of existing in widely different soil and climatic conditions. Probably the qualities acquired in any given situation are not such as to forbid a gradual or even ready tolerance for other conditions.

LOCATION OF INFECTED TREES.

Speaking generally, mistletoe-infected trees are those which occupy moist soils, namely, in river bottoms and along creeks and ravines leading to the uplands. In the South generally, certain swamp-inhabiting trees (gums and water oaks) are notably mistletoe hosts. There is no doubt a reason for this in the more or less constant demand which the mistletoe makes on its host for water. In the central Texas mistletoe belt this preference of mistletoe for trees of moist situations is obvious, but it is by no means limited to trees of such locations. Quite on the contrary, the most noteworthy and destructive instances of infection are on isolated trees or clumps of trees in dooryards or parks and along streets and highways. There is a notable preference for isolated trees. Even in timbered bottom lands the heavily infected trees are those which stand out conspicuously in or about a field or clearing. (Pl. I, figs. 1 and 2; Pl. II, fig. 1.) In close stands of timber the average tree seems much less likely to be infected than the same species in the open. Those which are infected in heavy stands are the trees which overtop their neighbors. Perhaps the need of mistletoe for abundant sunlight explains in part its absence in close forests and the predominance of it in exposed trees. This fact is of the greatest consequence in the present consideration, for while the loss to forest trees in a close stand is negligible, the concentrated attack of mistletoe on isolated trees is a blow on a vital spot, for the maintenance of adequate shade trees is a difficult matter, quite apart from the rôle played by mistletoe.

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[b] One correspondent states that mistletoe has been observed to grow upon China trees in southern Texas.

A further item of significance in this connection relates to the extension of mistletoe-infected areas. There exist quite obviously local centers of infection. These are most easily seen in cases where a large area is occupied by an open stand of mainly one species, such as the mesquite at San Antonio and the blackjack oak at Calvert. In traversing such timber lands one notes here an area of some square rods or acres in which almost every tree is infected, followed by a long stretch of timber land practically free from mistletoe.

METHODS OF COMBATING THE MISTLETOE.

An understanding of the habits of mistletoe, especially with respect to the mode of spreading the infection, will suggest that the surest way to prevent further spread of infection to new hosts would be to prevent any berries from ripening. This would imply, of course, the virtual extinction of mistletoe from any given community, and it may be questioned whether in spite of its harmfulness such an extreme measure is desired. As stated in the beginning, mistletoe has in many cases, if not generally, a traditional hold upon the regard of people which goes far toward condoning its harmfulness. It is reported that a certain prominent citizen in improving his residence property caused the branches to be pruned from one of his trees and mistletoe to be substituted therefor. (By what means and with what success is not stated.) Possibly one of the chief causes of the present conditions lies in the fact that in tolerating the growth because of its biological interest and because of its traditional setting the parasite has insidiously multiplied upon trees until it has become positively a pest. Those who have tried ineffectually for a decade or more to rid valuable shade trees of mistletoe will doubtless be ready to waive considerations of sentiment and tradition in favor of a radical movement looking to the extermination of the parasite.

The immediate problem is to deal with trees which are already infected. Here, again, a knowledge of the habits of mistletoe will show that where the infection is upon small branches careful pruning of these a few inches below the point where the parasite is attached to the branch will effectually get rid of it. The chief difficulty in this case is simply that of getting up high enough in the tree to do the pruning properly. This difficulty would be materially lessened by employing the common device in which pruning shears are attached to the end of a pole. The shears are operated by means of a heavy cord attached to the free lever arm. No indiscriminate lopping of branches or breaking them off with ragged fractures should be tolerated. Where, however, the infection is in the larger branches or on the trunk in which the cortical roots of mistletoe have ramified for years, and where innumerable sinkers penetrate the wood, the task of riddance is altogether more formidable. The embedded parts of the parasite are just as tenacious of life as are the rootstocks of Johnson grass, so that scraping or breaking off the external growth results, as in Johnson grass, in the sprouting up of more plants. Mistletoe, however, can be kept well under control by cutting off these successive crops of sprouts, and where this is done every year or two the trees are kept more sightly and the damaging effects of the mistletoe reduced to a negligible quantity. This method of treatment is the one most employed by those who devote any care to their trees; and it is here recommended as the most advisable procedure, except in cases where a skillful tree specialist is in charge.

The mistletoe plant is so brittle that it may easily be broken off, and by means of a hook attached to a long pole there is little difficulty in reaching any branches too large to be advisedly cut off. A better way, however, is to use a pruning hook attached to a pole. By this means the mistletoe may be cut off level with the bark and also many of the undeveloped buds destroyed, besides leaving the branch with a better appearance. The time and trouble, or the expense, required to keep trees free from mistletoe outgrowths in this way are really slight, compared with the advantage to be gained. A ladder of some kind, a pruning hook made by a blacksmith at the cost of perhaps a dollar, and two or three hours every year devoted to cleaning each tree will represent an average outlay. Naturally the best time to do this will be during the winter after the leaves have fallen, so that the mistletoe shoots may be more readily seen, but before the berries have become ripe enough to scatter the infection. If, however, the trees are gone over every year, or even every second year, there will probably be no question of berries on such young mistletoe shoots, and in that case the tree cleaning might better be done in the spring, when the parasite is ready to develop new shoots, thereby checking the new season's growth more effectually. This can be done before the new leaves on the host tree are large enough to conceal the mistletoe. In cases where the tree is full of mistletoe bunches the first cleaning up will naturally represent a greater outlay, for of course this will include the pruning of small infected branches, which is the most difficult and time-consuming item. In the larger towns and cities it is possible to employ experienced help in cleaning the trees of mistletoe, and this at no greater cost than that just indicated.

In some instances trees become so thoroughly infected that all the larger branches are sawed off close to the trunk, thus sacrificing the entire crown. In a dry climate like that of central Texas this is almost equivalent to sacrificing the tree permanently, for even though new branches are put forth the violent drying out at the sawed-off end of the branch extends back to the new branches, and they are killed. In such a case there would manifestly be much help in painting the cut surface with a heavy coat of tar or asphalt paint, or some other waterproof substance. This is advised in any case where a wound is made, as in scraping with a pruning hook or in cutting off small branches. It is questionable whether wholesale lopping-off of large branches is ever advisable.

POSSIBILITY OF ELIMINATING OLD INFECTIONS.

Can mistletoe be completely eliminated from large branches or trunks without fatal injury to the host? This bulletin does not pretend to give a satisfactory, or at least a final, answer based on sufficient demonstration, but it may present a statement of the case in the hope of calling forth more activity in the way of attempts to solve the problem practically.

Under the writer's direction, branches of a 10-inch hackberry were painted or smeared with the following preparations: (1) A strong wood preservative known as "carbolineum," (2) asphalt paint, and (3) laundry soap. In each case the mistletoe was shaved off flush with the bark before the preparation was applied. Also in each case a space was treated with the preparation and left without further covering, while a similarly treated space was wrapped closely with burlap. At the end of fourteen months (July 2, 1908) the report was as follows:

(1) Where carbolineum was used no mistletoe appeared, whether the branch was wrapped or not. The preparation had not perceptibly injured the branch.

(2) Where asphalt paint was used and the treated space not wrapped, mistletoe reappeared, but not until the following season. Where the treated space was wrapped, no mistletoe appeared after the wrapping was removed, eleven months from the date of its application.

(3) Where laundry soap was used mistletoe promptly reappeared as vigorously as before it was cut back and treated. On the wrapped branch mistletoe began to sprout up as soon as the wrapping was removed at the end of eleven months.

This report would seem to indicate that a strong preservative like wood creosote or carbolineum may be applied with a brush or cloth in quantity sufficient to kill mistletoe, without seriously injuring the branch or tree. Also that milder preparations, such as asphalt paint, coal tar, and white lead, may be applied with the result of checking the development of young mistletoe shoots, and by the additional precaution of wrapping the branch the parasite may be effectually killed.

TREE SURGERY AS APPLIED TO MISTLETOE INFECTION.

Another method of treatment will have suggested itself in the case of infected limbs which are too large to be advisedly cut off and in cases where the trunk is infected. Since the repeated development of mistletoe shoots takes place from buds formed on the cortical roots and since these roots extend only in the soft bark (cortex), why not cut away the bark and cortex down to the zone of young wood at these infected places? If the infection is a recent one or if the infected area is very small this would be a simple matter of applying a gouge or chisel locally, care being taken to cut far enough from the point of attachment of the mistletoe to include the spreading cortical roots. Thus there would result a small wound from 1 to 4 inches in diameter and extending into the branch perhaps one-eighth of an inch below the inner margin of the soft bark. This should be treated with an antiseptic wash, as indicated later, and painted with asphalt paint or coal tar or lead in oil.

In the case of old infection where the cortical roots have spread widely the removal of infected tissue could be accomplished also by means of chisel and mallet, but in such cases the size of the wound becomes a serious feature. In most cases of this sort it would be better to combine the surgical method with the chemical treatment and wrapping previously described. Thus with a chisel and mallet cut out each shoot or bud or bit of exposed cortical root of the mistletoe, making no wounds larger than the diameter of the shoot or bud removed; then paint with carbolineum and wrap with burlap, or treat with an antiseptic wash and then paint with asphalt paint, coal tar, or other waterproof dressing.

In this connection a word may be said about the general subject of mutilation of trees and the treatment of wounds in trees.[a] It should be understood that every wound on a tree invites disease from some fungous or bacterial infection. Unwise or careless pruning or trimming of trees is a source of much ultimate and really preventable damage. It is of course necessary to cause these wounds, but to leave them ragged and undressed is not necessary, nor is it any more rational than it would be to treat animals by the same cruel system of surgery. Whenever a wound is made on a tree, whether in ridding it of mistletoe or from whatever cause, it should be disinfected and dressed so that no disease spores can enter while the wound is healing over. The antiseptic wash may be prepared by dissolving 1 part of corrosive sublimate in 1,000 parts of water;

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[a] For further advice in this connection, see "Pruning," Farmers' Bulletin 181, by L. C. Corbett, and "Diseases of Ornamental Trees," by Haven Metcalf, in Yearbook, U. S. Dept. of Agriculture, for 1907.

or copper sulphate may be used, in which case 1 pound of the sulphate in 5 gallons of water makes a suitable wash. The protective dressing which follows this disinfectant usually consists of coal tar, but asphalt paint, white lead, grafting wax, etc., are used with good results. The edges of the wound should be left clean and smooth to facilitate the formation of wound tissue by which a tree attempts to heal over its wounds. In very dry seasons this dressing of tar or paint prevents the undue drying out which is apt to follow the cutting off of a branch. In unprotected stubs this drying out may kill the tissue several inches back of the cut end, and thus kill also the newly forming shoots, besides eventually causing a diseased spot. This precaution should especially be heeded by those who follow the practice—common in central Texas—of transplanting closely pruned trees, especially the young hackberry and cedar elm. The common custom of transplanting such trees without a ball of dirt around the roots and pruned back almost to the trunk is not advised as the best way to secure a rapidly growing, healthy shade tree; but if it is followed, surely the cut ends of the stubs should be painted to prevent drying out.

THE CARE OF TREES.

Perhaps after all is said it still remains that the most fundamental question involved in the enterprise of combating mistletoe is that of the selection and care of trees. It seems pretty obviously a case of neglect where a tree is allowed to become burdened with dozens of bunches of mistletoe until it becomes a deformed, unsightly object or completely destroyed. As a matter of fact, shade trees in well-kept grounds never do become so severely infected, or if they came into the careful owner's possession much infected their condition has been vastly improved. The trees which die of mistletoe infection are, in the majority of cases, those which stand along public highways, in unfenced or unimproved town lots, about neglected or abandoned residences, etc. They simply die of neglect.

That both the hackberry and cedar elm—the species which suffer most from mistletoe at Austin—may be kept healthy and free from mistletoe has been well demonstrated in numerous cases, but perhaps in none more strikingly than in that part of Austin which surrounds the university campus. This quarter has long been a center of harmful mistletoe infection. To the writer's personal knowledge numbers of trees have been killed outright by the pest in that vicinity. Plate I, figure 2, shows characteristically infected cedar elm trees standing opposite the west entrance to the campus. Just at the north of the campus are residence grounds bordered at front and side by a row of mixed cedar elm and hackberry trees. These trees are noteworthy for their vigorous and symmetrical growth and also for the fact that they have made an incomparably more rapid growth than certain specimens of the same kind of trees less favorably planted on the adjacent campus. Moreover, they are and have always been practically free from mistletoe. The pest has never gained a damaging hold upon these trees. Their freedom from it and their vigorous status otherwise are due to the exercise of a reasonable amount of intelligent caretaking which began with their being well planted in the first place.

It would be a misrepresentation of public sentiment to say that there is any lack of appreciation of trees or that careful attention is not given them; but it is fairly just to say that this appreciation and care are scarcely proportional to the large measure which trees contribute to human comfort and contentment and to the long time required to bring them to the stature where they do so contribute. Viewed from this aspect, all the minute details of care and treatment implied in the foregoing suggestions become fully justified. It would be rational, furthermore, to inquire whether, in view of the great value of the individual ornamental tree, it would not be worth while to abandon the custom of grubbing up the trees and setting them out like posts in favor of the more laborious and expensive but ultimately more profitable way of lifting each tree with its ball of earth and setting it in a well-prepared place with the least possible disturbance of its roots or mutilation of its crown. Even very small saplings thus carefully transplanted will eventually outstrip the very much larger transplanted "posts".

ORGANIZED EFFORT IN THE CARE OF TREES.

The specific problem of the eradication or control of mistletoe, as well as the broader one of selection and care of shade and ornamental trees, is of the kind to be taken up by some organization devoted to civic improvement. A well-organized, well-informed, and well-directed public sentiment would speedily solve these problems. The public schools may be made active allies of the movement in behalf of the care of trees, both in receiving and in disseminating information, and in otherwise arousing an enthusiastic spirit. City and county officials may by special enactment be authorized to include in their supervision the care of trees in public parks and along streets and highways. The individual owner may be led to feel a larger responsibility for the welfare of his trees, both for the benefit they bring him and for the relation they sustain to the welfare of the community at large.

THE COMMERCIAL IMPORTANCE OF MISTLETOE.

Mistletoe is used in Christmas decorations more or less throughout this country, but especially in northern cities. Within the range of the plant it is employed more or less in this way, especially by those to whom it is still a novelty. Countless packages of it are sent through the mails and by express to friends in the North. There is, however, a well-defined Christmas trade in mistletoe by which the markets in the North are supplied. The choicer and more expensive grades are handled by southern florist supply firms. Only well-berried shrubs are used in this trade, and these are crated with great care to insure against shattering and freezing in transit. These shipments reach the retail trade through the agency of northern firms dealing in florists' supplies. Even larger quantities of mistletoe are retailed in the northern markets by grocers and market men. These supplies are handled with less care and are cheaper than florist-trade mistletoe. Some of these supplies come from southern dealers in general merchandise, who add the handling of mistletoe as a special holiday feature of their business. The mistletoe is brought in by countrymen and its value taken in trade. It is then packed in barrels or crates and shipped to northern commission houses, and by them distributed to the retail grocery and market trade.

Apparently this Christmas trade has drawn upon mistletoe supplies only in relatively few localities. So far as the general supply is concerned the market might be widely extended. Judging by the appeal which this curious plant makes to the average person it would appear to be possible to greatly multiply the purchases of it throughout the North in smaller cities and towns, as well as in the larger, to which the market seems at present to be largely limited. On the other hand, there is constant inquiry from districts in which mistletoe is abundant for information as to the possibility of finding a market for it. An increased demand for mistletoe for Christmas purposes would constitute an important factor in the control of mistletoe as a pest, but as a matter of fact it is unlikely that the plant will ever be regarded very generally in that light.

SUMMARY.

(1) In general, the American mistletoe, like its European prototype, is more cherished because of its biologic interest and historic setting than feared for its harmfulness to trees. In some districts, however, notably in central Texas, its destructiveness as a tree parasite outweighs other considerations in its behalf.

(2) The region in which mistletoe is most destructive coincides with the transition from a humid climate favorable for forest growth to a dry climate less favorable for trees, and where the effects upon tree growth are such as to furnish the parasite more favorable light

conditions than in the closer stands and denser foliage of humid climate forests.

(3) The harmfulness of mistletoe is due in part to its mechanical injury to trees (deformity of branches and trunk, wounds followed by decay), but more especially to its drain upon the trees' vitality by withdrawing water and nutriment substances from them. The sinkers which connect the parasite with the water-transporting vessels of the wood and the cortical roots which ramify in the soft bark are the means by which the parasite withdraws substances from its host.

(4) The first infection of a tree by mistletoe takes place only through the agency of a germinating seed placed upon the body or branch of the tree by birds (mostly mocking birds, wax wings or cedar birds, and robins), except in the rare case where berries fall upon a branch from a bunch of mistletoe in an overtopping adjacent tree. The subsequent spread of infection upon a tree may take place by the falling or washing of berries upon other parts of the tree from the previously established mistletoe shrubs, or by the spread of cortical roots from which new mistletoe shoots arise. Spreading by cortical roots occurs more readily upon some species of trees than upon others, and is especially stimulated by the injury or removal of the original shoot.

(5) The mistletoe seed and seedling exhibit unusual powers of resistance to drying out, and are thereby enabled to survive in considerable numbers the critical period from the time the berry is placed upon a branch until the parasitic plantlet becomes established. This period may extend beyond the first growing season.

(6) A tree may become infected at any point where living tissue is exposed or covered only by a thin layer of cork with breathing pores, but the most vulnerable points are the young branches and, sometimes, buds. The sinker of the mistletoe seedling is able to penetrate certain tissues by dissolving the walls of cells lying in its path. It is uncertain whether cutinized or corky cell walls can be so dissolved, but the writer believes that they can.

(7) The trees most liable to infection are those which occur singly or in clumps or rows along streets and highways, in vacant lots and parks, along the border of fields, and narrow strips of timber along streams. The damage to trees in forest stands is negligible. Shade and ornamental trees suffer most.

(8) While it is not certain that any broad-leaved tree is wholly immune to attack from the American mistletoe, some are practically so, although freedom from infection seems to vary with locality. In the choice of trees for planting the question of the ability of a tree to resist infection might profitably be considered. It is believed that any tree subject to infection may be infected by seed from mistletoe growing upon any other species; e. g., the hackberry may be infected

by seeds of mistletoe grown on the elm, the live oak from those on the mesquite, etc.

(9) The damage to trees may be very largely overcome by breaking and scraping off the bunches and scattered sprouts of mistletoe every year or two. If the parasite is attached to small branches these may be pruned off a few inches below the mistletoe, and thus the infection be wholly removed at that point.

(10) Infection upon old branches and upon the trunk is very difficult to get rid of, because the cortical roots spread freely in the soft bark and any piece left there may give rise to new mistletoe sprouts. Since the cortical roots do not extend into the wood (of course sinkers do), the removal of the hard and soft bark clean to the wood about an infected spot should exterminate the parasite at that point. The objection to this method is that it necessitates large wounded surfaces. Such wounds should always be disinfected and afterwards coated with tar.

(11) In some cases mistletoe has been killed from old branches by the application of chemicals, which is made more effective by subsequently wrapping the limb with burlap. Thus carbolineum alone, and asphalt paint with burlap wrapping, were found to eliminate the infection.

(12) It is suggested that a combination of the above methods would be effective. First, remove with gouge or chisel the exposed shoots or buds of mistletoe down to the wood without making large wounds; fill the larger wound holes with tar, and paint the whole surface with carbolineum or with asphalt paint. When asphalt paint is used wrap afterwards with burlap.

(13) The cutting off of large branches in order to get rid of mistletoe is to be discouraged. It is apt to injure a tree more than the mistletoe would, particularly if the latter be broken or scraped off every few years.

(14) Every wound on a tree, e. g., those caused by digging out mistletoe or by cutting off branches, is a point of attack for disease-causing germs. Such wounds should always be disinfected and painted with tar or some similar waterproof coating.

(15) The mistletoe question resolves itself largely into the question of the care of trees. The spoiling or killing of trees by mistletoe is due chiefly to neglect. A well-organized movement in behalf of civic improvement would help to remedy this defect. City and county officials who have charge of streets and parks and public highways should be required to see that trees on public ground are kept free from mistletoe.

(16) The use of the mistletoe in Christmas decorations gives it a commercial status which has some bearing on the question of its control and extermination.

DESCRIPTION OF PLATES.

PLATE I. Fig. 1.—An isolated hackberry tree near Belton, Tex., with innumerable bunches of mistletoe. This tree is in its winter condition, being absolutely without leaves of its own. Fig. 2.—A cedar elm tree on a vacant lot in Austin, Tex., showing its winter condition. All the foliage is mistletoe.

PLATE II. Fig. 1.—A water oak tree in a creek-bottom field near Bryan, Tex. Numerous bunches of mistletoe 2 or 3 feet in diameter are shown at the ends of the slender branches. Fig. 2.—A deformed branch of a hackberry tree which has been infected by mistletoe for ten or twelve years. The dwarfing of the branch beyond the place of infection is shown. The original mistletoe plant has been destroyed, leaving a decayed spot. Young shoots of mistletoe from adventitious buds.

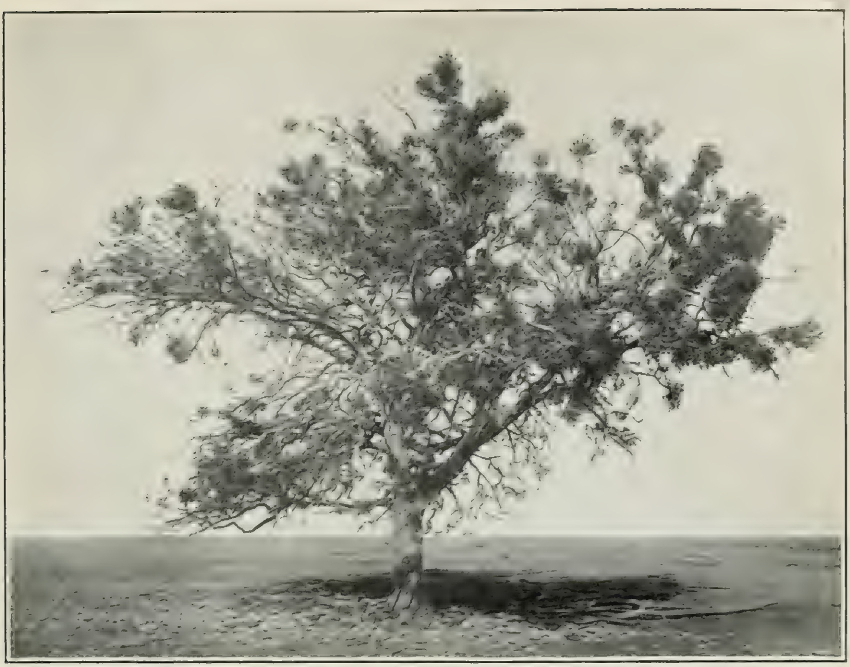

FIG. 1.—AN ISOLATED HACKBERRY TREE NEAR BELTON, TEX., WITH INNUMERABLE BUNCHES OF MISTLETOE.

This tree is in its winter condition, being absolutely without leaves of its own.

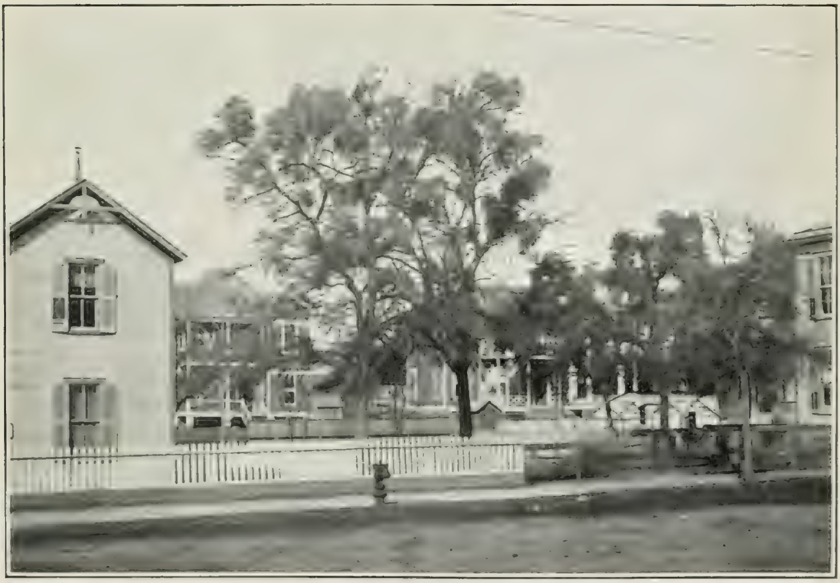

FIG. 2.—A CEDAR ELM TREE ON A VACANT LOT IN AUSTIN, TEX., SHOWING ITS WINTER CONDITION.

All the foliage is mistletoe.

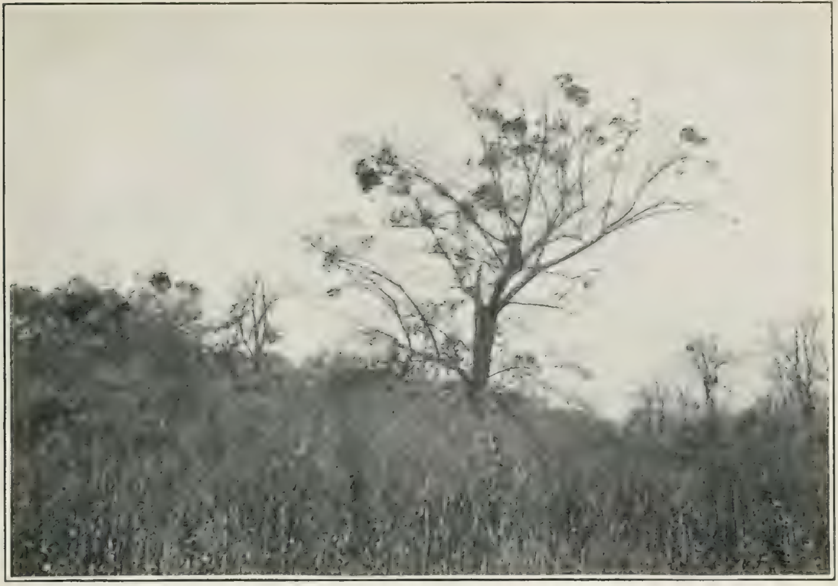

FIG. 1.—A WATER OAK TREE IN A CREEK-BOTTOM FIELD NEAR BRYAN, TEX.

Numerous bunches of mistletoe, 2 to 3 feet in diameter, are shown at the ends of the slender branches.

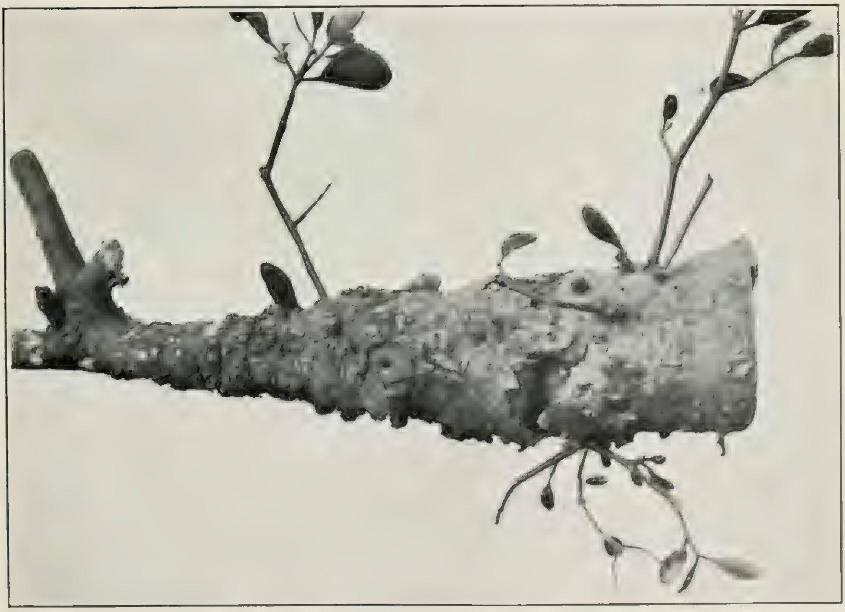

FIG. 2.—A DEFORMED BRANCH OF A HACKBERRY TREE WHICH HAS BEEN INFECTED BY MISTLETOE FOR TEN TO TWELVE YEARS.

The dwarfing of the branch beyond the place of infection is shown. The original mistletoe plant has been destroyed, leaving a decayed spot. The young shoots of mistletoe seen are from adventitious buds.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 167.

B. T. GALLOWAY, *Chief of Bureau.*

NEW METHODS OF PLANT BREEDING.

BY

GEORGE W. OLIVER, Plant Propagator.

Issued February 7, 1910.

1862 1889

239492
13 1 30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

BUREAU OF PLANT INDUSTRY.

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Assistant Chief of Bureau, Albert F. Woods.
Editor, J. E. Rockwell.
Chief Clerk, James E. Jones.

Foreign Seed and Plant Introduction.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 25, 1909.

Sir: I have the honor to transmit herewith a manuscript entitled "New Methods of Plant Breeding," by Mr. George W. Oliver, Plant Propagator of this Bureau, and recommend that it be published as Bulletin No. 167 of the Bureau series.

Respectfully,
B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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B. P. I.—516.

NEW METHODS OF PLANT BREEDING.

INTRODUCTION.

A few years ago Dr. B. T. Galloway, Chief of the Bureau of Plant Industry, mapped out some plant-breeding work for the writer which involved crossing varieties of lettuce, alfalfa, and cowpea, and also certain species of Poa, Trifolium, Melilotus, etc. The work in the beginning presented many difficulties which have since been overcome, and it is now progressing satisfactorily.

The improvement of plants by cross-breeding varieties is gradually becoming an important factor in the culture of many of our field and garden crops. The majority of intentional crosses and hybrids made in the past represent work which has been easy of accomplishment. The more difficult subjects have been passed by or at most the efforts of breeders with the hitherto refractory genera have to a large extent been nullified by natural obstacles in the path of success.

The only difficult part of plant breeding lies in knowing just how to make the most of a cross or hybrid which has been secured. The literature on this subject which has appeared during the last few years is apt, unfortunately, to lead the beginner and even the practical breeder into a maze, and he may conclude that the subject is too complex for comprehension.

This should not cause discouragement, however, because the mission of the plant breeder is to produce varieties which are in some measure improvements over the old ones, and each advance made will tend toward that perfecting of plant life which will insure better products for man and the domestic animals.

The present contribution to the subject deals not with laws, but with methods used by the writer in accomplishing what have hitherto been considered impossible or difficult crosses, and they may prove helpful to others engaged in the same line of work.

Until recently it has been found impossible to cross many plants owing to the fragile nature of the sexual organs. This difficulty has been removed, and the process whereby it has been accomplished is here described for the first time.

There are numerous plants, also, both ornamental and economic, the flowers of which are so small that their stamens are very difficult to remove in the process of emasculation, and this fact has undoubtedly contributed largely toward delaying the rapid improvement of many flowering plants, fruits, and vegetables by cross-breeding and hybridizing. Mendel, who did so much in his particular line, worked with two genera only: Pisum and Hieracium. The former is easy to manipulate, but all the species of Hieracium present difficulties in emasculation which by the ordinary methods are practically insurmountable. In fact, Mendel found them so great that he did not finish his work on this genus. Nevertheless, in the flowers of the hieraciums, and many other plants regarded as equally difficult, the pollen can be thoroughly removed, and with as great facility as in those of the rose or any other flower in which the reproductive organs are large and easily handled. This new process, which may be called "depollination," is the removal of pollen from the stigma before fecundation has taken place. It is applicable to flowers in which emasculation is impracticable because of the minuteness or delicacy of the floral organs. It is hoped that this newly found method of preventing fecundation by undesirable pollen will be instrumental in furthering the projects mapped out by the ever-increasing number of plant breeders.

The writer has worked on several genera of the Compositæ with complete success. The method here described can be used not only with the Compositæ, but also with all flowers having reproductive organs too small to be successfully manipulated by the ordinary methods of emasculation. The use of the method does not stop here. It can also be applied to the stigmas of larger flowers when there is any doubt whether pollen has recently gained access to the stigmas previous to artificial pollination.

ORIGIN OF THE NEW METHODS OF PLANT BREEDING.

During the spring of 1903 work was begun on the crossing of certain varieties of forcing lettuce. When the plants came into flower it was at once apparent that the problem of emasculation was a knotty one. The flower heads are small and the florets themselves will scarcely bear handling because of their very fragile nature. In one or two instances the stamens were removed, but always with sufficient injury to the remaining parts of the flower to cause it to wither. A flower of lettuce is in fact about as difficult to manipulate by the usual methods of emasculation as it is possible to conceive.

When the flower head expands, the anthers have already dehisced, and the unexpanded stigmas are covered with pollen. (See Pl. I, fig. 1.) The stigmas begin to expand at the tips, and simultaneously masses of pollen fall on the inner surfaces, to which the pollen closely adheres.

In the bud stage the parts of the floret are so easily damaged that endeavors along this line of attack were quickly abandoned. Having read somewhere that pollen grains would adhere readily to the end of a piece of sealing wax previously rubbed briskly, wax was tried, but without success. The idea then suggested itself that the pollen might be successfully removed with a dampened camel's-hair brush. This plan was also a failure, because with the operation ever so carefully performed some of the pollen grains were left on the stigmas.

Success finally came, not with the aid of a camel's-hair brush or sealing wax, but with the aid of the garden hose. A robust plant of the Grand Rapids variety of lettuce opened 15 flowers one morning, and within as many minutes every flower was successfully depollinated. The metal attachment on the end of the hose was cut off; a piece of hose of smaller diameter was placed in the end of the other hose; then a piece of soft rubber tubing of small diameter was placed inside the second piece of hose and the water turned on just enough to do a little more than trickle. By squeezing the end of the rubber tubing (see Pl. I, fig. 2) a very tiny jet of water was secured. This was trained on the lettuce flowers, and perfect depollination resulted.

After the tiny jets of water had played on each flower head for a few seconds not a trace of pollen was to be found and the pistils stood out from the ligules strong and unharmed. Small pieces of blotting paper freely applied to the florets edgewise soon absorbed all of the water. Pollen from the flower of another variety was then applied. In each of the 15 heads of flowers, seeds matured, and all of the resulting seedlings proved to be intermediate between the two parents.

In depollinating, the flower head is held securely between the thumb and the first and second fingers, and in pollinating it is similarly held. In applying the pollen to the stigmas one head of flowers from the pollen bearer is used, or more than one if sufficient pollen is not deposited on the stigmas. Before applying the pollen a few or all of the ligules should be cut off from the pollen-bearing head of flowers, leaving only the pollen-covered stigmas, and the remaining part of the head applied to the flowers which have been depollinated, working it among the stigmas with a circular motion.

In pollinating lettuce flowers and those of other genera in this division of the Compositæ there is not the same necessity for depositing the pollen on the stigma of each floret as there is on the flowers of the plants of the other divisions, because the lettuce flower heads close very soon after pollination. This act of closing will almost certainly cause the slender stigmas to become well covered with pollen because, in the act of pollinating, the ligules are apt to harbor many grains of pollen.

The first cross effected was between the varieties of lettuce known as Grand Rapids and Golden Queen, the former being the seed bearer. A short account of the subsequent behavior of the seedlings may be of interest here as a guide to similar experiments in the future.

The crossing was commenced about the beginning of July. From the application of pollen to the ripening of the seed, sixteen days elapsed, the time varying slightly according to the condition of the weather—warm, dry weather accelerating the ripening period.

The seeds were sown in the latter part of December in order to make certain that the seedlings during the later stages of growth would have the benefit of warm weather and thus insure seed production.

Seeds of each parent were also sown separately for comparison with the crosses in all stages of their growth. Even in the cotyledon stage differences were noted between the cotyledons of the crossed seeds and those of the parents; they were uniformly not as light in color as those of the Grand Rapids, neither were they as deep a yellow as those of the Golden Queen, but any doubt arising as to the differences in color, size, and form of the cotyledons of the crosses compared with those of the parents was dispelled as soon as the first character leaves appeared in the crosses. The first leaf of the cross Grand Rapids × Golden Queen was similar in every respect to the first leaf of the cross Golden Queen × Grand Rapids, thus proving beyond a doubt at that early stage that the mere act of crossing had been a success. The plants of the two crosses could not have been distinguished, so similar were they in appearance.

A large-sized Grand Rapids lettuce, but more yellowish in appearance than that variety, with the leaves slightly less crumpled and the margin less fringed, would be a fairly accurate description applicable to both lots of plants of the first-generation crosses.

Seeds harvested from each of the plants were labeled and sown separately. In the second generation the results were rather bewildering. The seeds from each plant of the first generation gave approximately 30 distinct forms, and out of the entire number of seedlings of the different numbers about 60 distinct forms were noted. Forty-five plants of these were selected for further testing, and it so happened that the plant numbered 39, selected as being the best in the field, gave the most promising progeny when sown indoors. Several were then selected for fixing. Four distinct forms have come true from seed in 1908. The fifth and last of the heading varieties up to that time had about 15 per cent of seedlings resembling the Grand Rapids variety. By selecting seed from each of 36 of the best heading individuals and sowing separately, about two-thirds of the lots have come true. These will be tested still further before being sent out for trial.

TOOLS REQUIRED FOR DEPOLLINATION AND EMASCULATION.

A small pair of scissors is necessary to remove parts of corollas, stamens, etc., of the different flowers. Those shown in figure 1, *A*, are more convenient for use on many subjects than the common scissors, as they can very readily be adjusted to the various needs with one hand. A medium-sized pair of the ordinary kind of scissors used by plant breeders, with blades 1 inch in length, figure 1, *D*, is also necessary.

Forceps are indispensable tools. Those forceps in common use would be better adapted to the needs of the plant breeder were they supplied with a flattened pin attached to the handle (see fig. 1, *C*). This would often prevent the necessity of laying down one tool to take up another while the operator is performing a delicate piece of work and while the eyes are perhaps fixed on a very small object. A needle can be tied on very easily and the combination is an exceedingly useful one. Several pairs of forceps which are self-closing (shown in fig. 1, *B*) are necessary in such lines of work as pollinating depollinated stigmas of alfalfas and many other small flowers. These forceps enable the operator to hold a stamen or a sexual column of a small legume while pollinating. It is difficult to perform this work satisfactorily with the fingers.

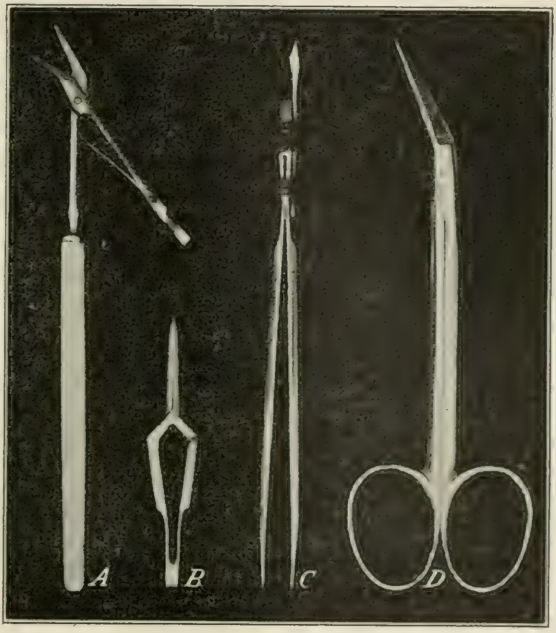

FIG. 1.—Tools used in depollination and emasculation: *A*, scissors useful in removing small organs; *B*, self-closing forceps; *C*, forceps with attachment; *D*, scissors for severing large organs.

Watch glasses and small-sized moist chambers are needed to preserve pollen. Tags for keeping records while the seeds are ripening, ranging from one-half inch by three-quarters inch to those of much larger dimensions, are indispensable. Some small-sized camel's-hair brushes, some good white blotting paper torn into small pieces, and a lens should also be included in the kit.

DEVICES USED IN DEPOLLINATING FLOWERS.

The contrivances required for the work of depollination by water are inexpensive and easily secured. When the method was first used attachments to the garden hose were employed, but these were found too clumsy and uncertain; moreover, the hose is not always available when it is desired to depollinate flowers in the field. A fairly good substitute is a modification of the common putty bulb (fig. 2, *E*). This answers the purpose very satisfactorily for large flowers of the Compositæ, Leguminosæ, and other groups. The putty bulb will hold about a pint of water. By unscrewing the spout or ejector, the rubber bag may be quickly filled with water and the ejector replaced in a few seconds. The size of the jet of water is regulated by using a suitable piece of bamboo reed or other contrivance fixed firmly in the tube. When the bulb is full of water a slight pressure with the hand will cause a fairly strong but fine stream of water to be emitted.

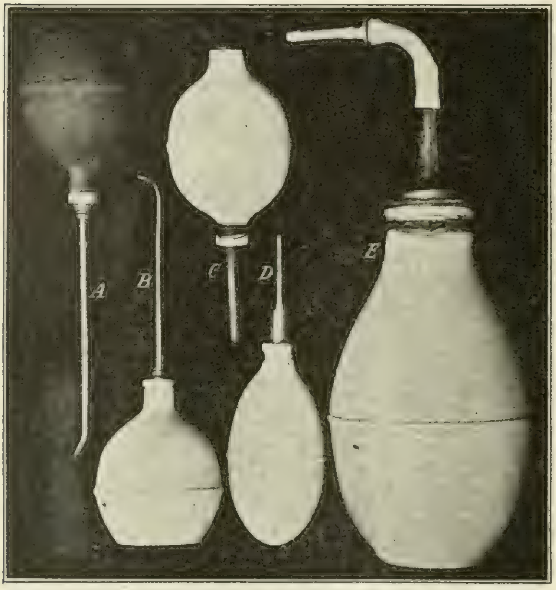

Fig. 2.—Devices used in the depollination of flowers: *A* and *B*, chip blowers or water bulbs; *C*, water bulb with valve at bottom provided with celluloid ejector; *D*, old rubber bulb with glass tube inserted; *E*, "putty bulb" with attachment to give a small jet of water.

It will be found that a very small jet of water is needed for very small and fragile flowers. For this purpose the various kinds of chip blowers (fig. 2, *A* and *B*) and water bulbs sold by dental supply companies suit the plant breeder's needs admirably. These devices are inexpensive, and when many flowers are to be treated at one time several of the chip blowers or water bulbs may be brought into use. As soon as the contents of one are exhausted and while the bulb is still pressed in the hand it may be put in a vessel of water; then when the others are emptied of their contents the first one will be ready to be used again.

There is a still further choice in instruments of this nature in the shape of rubber bulbs (fig. 2, *C* and *D*) similar to those used on cameras.

A piece of glass tubing can be pushed into one of these; the other end of the tube can be brought to a fine point by heating it in a flame and breaking off the point, leaving an aperture about one-sixteenth inch in diameter. This device does satisfactory work, but the others are preferable.

EMASCULATION.

A necessary preliminary to successful plant breeding by hybridization or cross-fertilization consists in preventing pollen of the plant used as the seed bearer, or pollen from other plants of the same variety or species, or pollen of any other closely allied variety or species from gaining access to the stigmatic surface of the flower intended to be pollinated instead of the pollen selected by the operator.

With the greater number of plants, especially those having stamens of large size, emasculation is a simple matter, and consists of removing the stamens before the anthers shed their pollen. Examples of plants having large stamens are found in the rose (see Pl. XI, fig. 1), cherry, peach, etc. The poppy, carnation, and tobacco are also familiar examples in which emasculation is an exceedingly easy process, as the stamens can be removed before dehiscing with a pair of forceps.

OBSTACLES IN EMASCULATING THE FLOWERS OF COMPOSITÆ.

It is well known that the florets of the various genera of the composite flowers are so constructed that the anthers can not be removed without the florets being injured beyond recovery.

The anthers in the disk florets unite and form a tube (Pl. VIII, fig. 1, *B*, and Pl. IX, fig. 1, *B*) over and around the upper part of the immature pistil so that in the effort to remove this tube before the floret opens or the anthers dehisce the anthers are certain to be ruptured and the pollen scattered over the stigma. The parts of the florets are so small that it is practically impossible to remove the anthers in a young stage without ruining the florets. There is also great danger of injuring the very slender pistils during the attempted emasculation. Some genera have only female organs in the ray florets and both male and female in the disk florets, and in some important genera some species have sterile ray florets and depend on the disk florets alone for fertilization. (Pl. V, figs. 1 and 2.) But to depend on the ray florets alone for careful crossing means in all instances slipshod work, as the disk florets must then all be removed, causing too much mutilation of the flower head. Depollination of the disk florets by the method herein described (Pl. VIII, fig. 2, *B*) means that the work is absolutely certain to produce the desired results. Moreover, depollination of the disk florets followed by crossing is many times easier than the use of the ray florets as seed bearers, as this is necessarily followed by the removal of the disk florets to prevent self-pollination.

In several genera of the Compositæ it will be found that the staminal tubes are not drawn down into the tubular corolla until the second day after shedding the pollen. This happens with some of the species of Helianthus (Pl. IX, fig. 1, *B*), Gaillardia, etc. A short, sharp needle fixed in the end of a piece of wood less than the diameter of a pencil and 4 inches in length can be very successfully used in opening the collar formed by the united anthers around the stigma, so that it may be depollinated before the pollen grains germinate. All of the crop of florets which come out in any single day can be opened after the manner described, the pollen washed from them, and the flower head bagged, pollination being delayed until the following day, when the circles of florets contiguous to those already depollinated will have come to maturity. These are in turn treated with the needle and depollinated by water. The remaining unopened florets may then be pulled out with a pair of forceps, the two lots of treated stigmas pollinated at the same time, and the flower head bagged. A method still easier is to depollinate the two outer circles of stigmas and then remove them with the aid of a pair of forceps, which in the larger number of genera is easy of accomplishment. When the remainder of the florets expand, depollination is effected and the flowers are pollinated as soon as the flower head is cleared of water (Pl. VII, figs. 1 and 2). In all composite flowers which attract insects the head should be bagged to prevent undesirable pollen from gaining access to the stigmas after being pollinated.

It may be said that unless the method of depollination herein described is used with flowers of the Compositæ, especially those of the division Liguliflorœ, there is very little chance, if any, of absolutely certain results from cross-fertilization between different varieties of the same species or from hybridizing distinct species.

HOW HYBRIDS AND CROSSES OF COMPOSITE FLOWERS MAY HAVE ORIGINATED IN THE PAST.

It is quite possible that a long continuous shower will wash the pollen from the stigmas of a composite flower and that as soon as the sun shines these flowers are visited by insects whose bodies are occasionally covered with pollen obtained from florets of other varieties or species which open and shed their pollen, either before or subsequent to the pollen-removing shower of rain. It is certain that cross-fertilization may take place in this way. Those species and their varieties having infertile ray florets can be crossed only when the disk florets, containing both male and female organs, are used as the seed bearers. (Pl. VII, figs. 1 and 2.) All of the work in breeding composite flowers is rendered simple by the depollinating method. Especially is this the case with chrysanthemums, asters, dahlias (Pl. VI, fig. 2), marigolds, cineraria (Pl. VI, fig. 1), cosmos, zinnias, lettuce, and with all the numerous genera having infertile ray florets.

PREPARATION OF SEED AND POLLEN BEARING PARENTS.

Too much care can not be bestowed on isolating from insects the plants from which pollen is to be selected for use in crossing. This is a part of the plant breeder's work which is apt to be neglected. Pollen is usually considered satisfactory irrespective of the conditions under which the flowers have been produced. It is not unnaturally supposed that the pollen is pure while the flowers are in the bud stage, and although this is the case in many instances, especially where large numbers of one variety or species are growing side by side, yet there is no doubt that the pollen of these plants is often interchanged, as in alfalfa and other plants of the legume family in which the anthers dehisce in the flower bud and which are visited by the pollen-eating thrips.

Much experimental work in plant breeding by crossing and hybridization gives negative results through lack of care in the selection of pure pollen. It is just as necessary to protect the flower selected to supply the pollen, in order to prevent foreign pollen from being deposited on or near the anthers either by insects or by wind, as it is to protect the seed-bearing flowers. In selecting pure pollen it is a good plan to have isolated plants growing in pots in the greenhouse, where they can be protected from insects during the flowering period by wire screens. If this is not feasible, the flowers should be bagged when the buds are nearing the opening stage, to prevent insects from depositing pollen on or near the flowers. Absolute success means careful attention to the very minutest detail. Omission of the necessary care in this respect has undoubtedly caused a vast amount of work to be unproductive of good results. Not only should the pollen bearer be grown under glass, but in every case where it is possible the seed-bearing parent should also be grown in this manner in order to have the work absolutely under control. Even then with the aid of wire screens only the large insects can be kept from the flowers as the pollen-eating thrips found in nearly all flowers is one of the greatest carriers of pollen from flower to flower. It is not unusual to find one of these minute insects with several grains of pollen attached to its body, rendering the work of evidently careful emasculation of no avail. The plants infested with these insects should be treated to a slight fumigation with hydrocyanic-acid gas and afterwards protected with structures covered with some kind of fine white fabric to prevent the flowers being visited immediately before emasculation and until fertilization takes place.

CONDITION OF THE STIGMA AT THE TIME OF POLLINATION.

It has often been stated that the stigmatic surface of the pistil must be free from moisture when the pollen is applied. When the contrary condition is present, the pollen is said to be less effective than it would be were it applied to the stigma when free from moisture deposited from the atmosphere. Be this as it may, it is absolutely certain that pollen is as effective when applied to stigmas which have been thoroughly treated with water and the moisture adhering to them partly removed with the aid of bibulous paper applied edgewise as it is when the stigma has not come in contact with water.

THE APPLICATION OF WATER TO ALL FLOWERS.

For the removal of pollen which may have been deposited upon the stigma of a flower previous to pollinating, water should be used in every case where the flower has been exposed through inadvertence or otherwise to the visits of insects. Its use in such a case, if it be applied within a certain period after the pollen is deposited, is desirable, as it will render the operation of crossing with another flower more certain, because if pollen is present on the stigma of a flower, especially if the pollen be of the same variety or species as the flower which it is desired to use as the seed bearer, its own pollen will in many cases take effect in preference to the pollen of the flower of a separate species or variety.

Another case may be mentioned in which this adjunct to perfect emasculation can be used advantageously. It sometimes happens that an operator comes across an open flower of some kind which he may wish to cross, with the stamens already dehisced and the stigmas well covered with pollen. If the pollen has been deposited on the stigmas for only a short time, in most flowers every grain can be removed effectively by the aid of the depollinating method herein described. In the case of lettuce the flowers have been depollinated after the pollen had been in contact with the stigma for an hour and a half and a successful cross has followed.

CROSSING ALFALFA.

WORK ACCOMPLISHED IN THE PAST.

For the purpose of demonstrating how the new method of preparing flowers for crossing can be applied to a wide range of subjects, alfalfa may be taken as an example. While it is true that alfalfa crosses and hybrids are effected by insects, the genus is an exceedingly difficult one to deal with by ordinary methods of emasculation, and there is probably no record of intentional crosses among the many forms of *Medicago sativa*[a] or hybrids between it and other species, if we except those of Urban,[b] who succeeded in making reciprocal crosses with *Medicago sativa* and *M. falcata* in 1877. The work of Urban, however, was evidently done without taking the necessary precautions to preclude the possibility of error, as the pollination was a crude imitation of that effected by insects.

We can not afford to relegate the crossing of the varieties of this increasingly important plant to insects or to risk pollen of unknown or undesirable forms on the plants we wish to cross. If we were to copy the insect method, we should, of course, get crosses, but we should remain as much in the dark concerning the parentage of the seedlings as we have been in the past.

PECULIAR FEATURES OF THE WORK.

None of the species and varieties of alfalfa sets seed from self-pollination if the flowers remain untripped (Pl. II, fig. 1, *A*). The pollen in the untripped flower, being of a slightly adhesive nature, does not get an opportunity to move after being discharged from the anthers while still within the closed keel, and after the dehiscing period the surface of the stigma is protected from it by being close against the keel. This is the case with the flowers of most of the varieties, but there are forms the flowers of which often have the stigmas completely hidden by the pollen (see Pl. III, *C*), and yet even these do not set seed if the flowers remain untripped.

When, however, the flower is tripped (Pl. II, fig. 1, *B*), either by drawing the closed hand along the raceme or by snipping the individual flowers with the forceps, this action releases the column from its imprisonment within the keel and permits it to spring upward with a very rapid movement. In doing so the pollen grains are thrown on the banner in large numbers and the stigma falls with force among them, causing a mass of the grains to be embedded in it (Pl. II, fig. 1, *B*). This action usually results in fertilization.

When the flowers are visited by certain insects, the upper part of the sexual column falls with considerable force on the under part of the insect. The stigma in this case is then partly pollinated with pollen from the same flower, from other flowers on the same plant, or from flowers of other plants of the same variety or from other varieties, or from pollen of other species previously deposited on the body of the insect.

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[a] The botanical history and nomenclature of this species have been discussed in previous publications of the Bureau of Plant Industry; by C. S. Scofield in Bulletin 131, part 2, "The Botanical History and Classification of Alfalfa," and by Charles J. Brand in Bulletin 118, "Peruvian Alfalfa: A New Long-Season Variety for the Southwest."

[b] Urban, I. Verhandlungen des Botanischen Vereins der Provinz Brandenburg, vol. 19, p. 125. 1877.

OLD METHODS OF CROSSING ALFALFA.

Perhaps the method first used in crossing alfalfa, at least so far as can be ascertained, consisted in introducing a sharpened piece of wood, resembling in shape the proboscis of a bumblebee, into the suture formed by the blades of the keel of the pollen bearer. The piece of wood was dusted over with pollen secured by allowing a sexual column to trip on it. It was pushed into the suture of the flower of the proposed seed bearer, and the resulting tripping of the column caused the stigma to come in contact with the pollen already secured on the piece of wood, the supposition being that, in some cases at least, foreign pollen is prepotent over that of the seed bearer on its own flowers.

The second method—one which the writer tried several years ago—consists in emasculating the flowers in the bud stage, but as the anthers dehisce before the buds expand the operation must be performed when the buds are quite small, and the danger of bruising the flower enough to cause it to wither is great. This operation is easily performed with the aid of a binocular dissecting microscope, but even when the parts of the flower are left uninjured the method is clumsy and exceedingly uncertain.

Another method which involves a considerable element of uncertainty consists in planting one or more plants of a known variety in the midst of a large field of another variety. These plants are used as seed bearers and the work of pollination is left to the insects.

Thus it will be seen that when a cross of known ancestry is desired between two varieties of alfalfa the chances of securing it by methods heretofore in vogue are very remote.

NEW METHODS DEVISED BY THE WRITER.

A few years ago, while investigating methods of crossing alfalfa and trying to cross a hardy form of Peruvian alfalfa with a variety from Turkestan, it was found that there are at least three variations in the method of compelling this plant to capitulate readily to the wishes of the plant breeder.

DEPOLLINATION BY WATER.

The first method to be described requires close attention to details. The tools and other necessary material are as follows: Four pairs of forceps, three of them self-closing; a pair of scissors (see fig. 1, *A*); a few pins; a small chip blower such as dentists use (see fig. 2, *A* and *B*); a vessel of water; and some pieces of good blotting paper.

The operations of depollinating and applying pollen to the stigma can be performed satisfactorily with the unaided eye, but the operator should take his first lesson with the aid of a low-power binocular dissecting microscope. The magnification should not be higher than 8 diameters.

Three or four flowers on a raceme should be selected for crossing. The others may be cut off, although this is not necessary if they be tripped and the surplus pollen removed by washing with water. However, when all but three of the flowers on a raceme are removed, those intended for crossing can be reached more easily. The age of the flowers used as seed bearers for crossing seems to make little difference, provided they do not show signs of withering. It is perhaps the safer plan to select those flowers near the center of the raceme just when the buds at the end of the raceme are about to expand. The flowers should not be mutilated in any way, and of course should be handled as little as possible because of their delicate nature.

The first requisite consists in having pollen from the male parent at hand ready to be applied to the prepared stigmas. To do this most conveniently, as the flowers can not very well be manipulated with the fingers alone, it is desirable to have three pairs of forceps, one for each flower that is to be pollinated. Self-closing forceps are best, because they hold firmly the sexual column (Pl. III, *C* and *D*) used in pollinating. Take a flower from a raceme of the male parent, bend down and secure the banner between the tips of the thumb and the forefinger, then press with a pin or dissecting needle sidewise against the suture of the keel, beginning at the base and gradually drawing upward. If this operation is done carefully, the column will come out gently without disturbing the pollen from the anthers. When the flower has been tripped or exploded in this way, the terminal part comprising the stigma, with the masses of pollen surrounding the empty anthers closely arranged around it, hangs toward the operator free from contact with anything. With the aid of the self-closing forceps, sever the column from the flower, laying the columns aside ready to be applied to the stigmas of the flowers of the seed bearer when the latter is depollinated.

Now comes the most critical part of the operation, and the amount of skill with which it is performed determines the success or failure of the work. It must be understood that in the flower to be used as the seed bearer the stamens dehisced while the flower was in the bud stage, perhaps a day or two previously, and the pollen lies in masses all around the soft stigma (Pl. III, *C* and *D*), but still incompetent in that position to perform the acts of pollination and fertilization while the column is untripped. It should be the aim of the operator to trip the column in a manner that will cause a minimum disturbance of the arrangement of the pollen and prevent the terminal part of the column containing the sexual organs from springing with considerable force on the awaiting banner, thereby embedding a large number of its own pollen grains in the soft, pulpy stigma.

With this end in view, grasp one of the flowers gently but securely between the tips of the thumb and forefinger, with the back of the keel resting against the tip of the index finger. Cut an ordinary small-sized pin or needle in two, take the pointed end between the thumb and index finger of the free hand, place the half pin or needle against the lower part of the suture of the keel, and press gently against the keel, bringing the pin or needle up to the central part or a little beyond it, increasing the pressure gradually. This will compel the sexual column to alter its position, or "trip," gradually as the gentle pressure of the pin retards or prevents its springing with force enough to disturb the arrangement of the pollen grains around the stigma. Allow the pin supporting the sexual column to come gently toward the awaiting banner. It will then be found that, with the pin resting on the banner, the fingers may relax their hold, the pressure of the column toward the banner keeping the pin in place; and owing to the position of the pin, for the time being the terminal part of the sexual column, consisting of stigma and an abundance of pollen around it, is prevented from pressing on the standard, as it is about one thirty-second to one-sixteenth of an inch above it. (Pl. II, fig. 1, *C*, and Pl. II, fig. 2.) This gives the opportunity for the removal of the pollen grains by the use of a jet of water from the chip blower.

The action of the water effectually depollinates the flower without causing the least injury (Pl. II, fig. 1, *D*); in fact, the jet may be of sufficient force to remove even the empty anthers without injury to the stigma. (Pl. III, *E* and *F*.) However, the first few flowers operated on by the beginner should be examined before proceeding with the pollination to ascertain if the treatment given has been sufficient to depollinate the flower thoroughly.

After the jet of water has been applied there will be a considerable quantity of moisture covering the different parts of the flower, especially the empty anthers and stigma. This is immediately removed by touching these organs and other parts of the flower with a piece of blotting paper applied edgewise.

When this operation has been completed the exposed stigmas are pollinated in the following manner: Take one of the self-closing forceps, holding one of the previously prepared sexual columns from the flowers of the male parent, and with the stigma pointing upward push the end of the column containing stamens and freed pollen closely surrounding the stigma under the end of the column which has been depollinated, giving it a very slight circular movement to make certain that the large masses of pollen come in contact with the soft stigma of the depollinated flower. When this has been satisfactorily done, take hold of the supporting pin by the blunt end and gently withdraw it; the column then assumes its place on the banner with the stigma closely pressed against its surface (Pl. II, fig. 1, *F*), and a goodly number of pollen grains are embedded in the soft stigmatic surface. When the supply of pollen is unlimited a number of flowers may be tripped over a watch glass and the pollen applied to the stigma with a small brush, the hairs of which are held together with a weak sirup of sugar and water.

If the details described are carried out in a painstaking way, all that is done simply consists in substituting pollen from another variety for that which originally surrounded the stigma of the flower of the proposed seed bearer.

The operation is performed in much less time than it takes to describe it, and the operator is rewarded by a fairly high percentage of successful crosses. The first time the writer tried this method with two distinct varieties of *Medicago sativa* more than two-thirds of the flowers worked set seeds.

The second method of crossing alfalfa also involves depollination with the aid of a jet of water on the dehisced stamens, but it has now been discarded in favor of that just described. It is a simpler operation, requiring less delicate manipulation, but the percentage of successful crosses by it is very low. Besides, it involves the mutilation of the floral envelope and the exposure of the pollinated stigma to the atmosphere instead of allowing it to assume its natural position on the banner of the flower after being pollinated.

By this method all the flowers on a raceme may be used. First, by the aid of the scissors shown in figure 1, *A*, cut off all of the unopened buds and the banner of each flower left on the rachis. The reason for removing the banner is that when the flower column is tripped the position of the sexual column is altered so as to free it from contact with anything and to render it readily accessible.

The depollination of the flower thus becomes a very simple problem. The sexual column, being still imprisoned within the keel, is best tripped by a very light snip given by a pair of forceps, care being taken to place the tips of the forceps at a point near the base of the column so that the stamens and pistil are not interfered with in withdrawing. The sexual column being now free from the keel, the latter, together with the wings, should be cut off.

A small jet of water is then trained on the sexual organs from a water bulb or chip blower (see fig. 2, *A* and *B*); the stream should be quite gentle at first, followed with just sufficient force to remove both pollen and empty anthers. This will facilitate an easy approach to the stigmas when pollinating. Examine the stigmas with the aid of a lens to ascertain if all of the pollen has been removed; then remove the surplus water by applying lengthwise a piece of thick and very bibulous blotting paper. The flowers are now ready to be pollinated.

In preparing the sexual column of the pollen-bearing flower so that the pollen may be easily and quickly applied to the stigmas of the depollinated flowers of the seed bearer, detach one flower at a time and pollinate as described for the first method of crossing. If the pollinated stigmas are left exposed to the air, fertilization takes place only in a very small percentage of the flowers. They give a higher percentage when protected by a small paper bag, or each raceme may be placed inside of a test tube and kept in place by a small wad of cotton for twenty-four hours after pollination, the test tube being tied to a support and shaded from direct sunlight.

DEPOLLINATION BY COMPRESSED AIR.

The third method by which alfalfa and other flowers have been successfully depollinated is the use of compressed air. Contrary to expectation, this has no injurious effect on the tender parts of the pistil.

The parts of the flower are prepared in a manner similar to that described in the first method. The current of air is obtained from a small cylinder into which air is pumped to an indicated pressure of 20 pounds. The nozzle of the air tube is held about half an inch from the terminal part of the column by a helper; the full force is turned on just when the column is about to spring from the keel and is continued for ten or fifteen seconds after resting on the pin.

Pollination and subsequent treatment are performed in the same manner as given for the first method.

Fertilization following this method is satisfactory, but the percentage of successful crosses is not as high as in the first method described.

In depollinating large flowers of other genera having pistils that may be easily injured, it is very helpful to remove large quantities of pollen previous to the more thorough work by a jet of water from the chip blower.

THE GROWING OF THE PLANTS AND THEIR CARE.

In order to have the parent plants of alfalfa intended for crossing thoroughly under control, they should first be raised from seeds to ascertain if the varieties come true. The plants to be crossed should be grown in a cool greenhouse and when of sufficient size put in large pots, as then they are less apt to become suddenly dry at the roots. Good fibrous loam and a little rough sand make a good soil for pot culture. To prevent souring of the soil, place some large potsherds over the drainage hole, and over these place some half-rotted leaves. Ram the soil moderately firm around the roots, leaving sufficient space to give enough water at a time to last for two or three days.

It should be the aim of the cultivator to have the plants in bloom about the end of March or the beginning of April. At that season the absence of insects will render the work easier of accomplishment than when grown outdoors. Under outdoor conditions the plants would require to be protected by wire or cloth screens to exclude pollinating insects. Several specimens of each variety to be worked with should be grown to make certain of having some of them in bloom at the proper time. A strong plant of the variety to be used as the seed bearer should be selected.

RAISING LARGE QUANTITIES OF SEED FROM A CROSS.

When a promising variety of alfalfa has been secured by crossing, the problem of how best to secure a quantity of seed to sow a large area is undoubtedly a serious one. In the first place, the plants should be tested thoroughly to ascertain if they are superior to existing forms. The crosses obtained so far do not seem to vary much in the second and succeeding generations when seed is saved from flowers tripped by the hand. Those that prove of value from a single cross, the individuals of which are evidently alike, should be propagated vegetatively and the progeny of each plant kept separate till planted out in the field, when they may be mixed for cross-pollination. The cuttings will root satisfactorily in a cold frame if kept closed for a few days. It is possible by this method to root several hundred cuttings during the summer, beginning with a single mother plant in the spring, but it must be understood that these cuttings originating from a single mother are to be considered as one plant; that is, if seeds set poorly on the mother plant as a result of self-pollination by artificial tripping, all the plants propagated asexually from the original will have the same peculiarity. If the asexually propagated progeny be planted in a field a safe distance from other varieties, the probabilities are that the plants from the resulting seed will come true and the strain be established. In this way a much larger crop of seed can be secured in a given time than if one depends altogether upon seeding the original individuals of a cross.

CROSSING LARGE-FLOWERED LEGUMES.

In crossing varieties of legumes which come true from seed resulting from self-pollination, it is not necessary to work with a large number of flowers. Careful manipulation of a few will give all the possible results with any two varieties, and usually the operator will get more varieties than he desires in the second and subsequent generations. The flowers of such plants as Phaseolus, Stizolobium, Vigna (Pl. IV, fig. 1), Pisum, and Lathyrus should be emasculated in the bud stage and before the anthers shed their pollen. The operator before under-taking to cross two varieties should have a perfect knowledge of the parts of the flower.

The idea of having large models of the various flowers of the principal garden and field crops in agricultural colleges and schools is a good one. It enables prospective plant breeders to become familiar with the structure of the common flowers and shows what is necessary to be done in preparing flowers for crossing more quickly than the study of the flowers themselves or the use of illustrations made by others. Many of the flowers of forage plants and vegetables are so minute that it is with difficulty that they are emasculated even with the aid of a good dissecting microscope. This is the case with all the species of Melilotus and a goodly number of the species of Medicago and Trifolium; and the student, having the forms and structure of the flowers continually in his mind, will be better prepared to cope successfully with plant-breeding problems.

Among the large-flowered legumes, varieties of which it is desired to cross, the cowpea may be chosen as a good example in order to show how the flower is manipulated previous to pollinating. In the evening it is found that the buds which will expand the next morning are quite large and easily manipulated in emasculating. (Pl. IV, fig. 1, *A*.) Hold the bud between the thumb and the forefinger, with the keeled side uppermost (Pl. IV, fig. 1, *B*); then run a needle along the ridge where the two edges of the standard unite. Bring down one side of the standard, securing it in position with the thumb; then do the same with one of the wings, which will leave the keel exposed. This must be slit on the exposed side about one-eighth of an inch below the bend in the keel and continuing along until about one-sixteenth of an inch from the stigma, which can be seen through the tissue of the keel. Bring down the section of keel and secure it under the end of the thumb. This will expose the immature stamens, 10 in number. (Pl. IV, fig. 1, *B*.) With a fine-pointed pair of forceps seize the filaments of the stamens and pull them out, counting them as they are removed to make certain that none are left. (Pl. IV, fig. 1, *C*.) Allow the disturbed parts of keel, wings, and standard to assume their original positions as far as possible. Next detach a leaflet from the plant, fold it once, place it over the emasculated flower bud, and secure it in position with a pin or toothpick. This will prevent the bud from drying out before the stigma matures sufficiently to be pollinated from a flower of a different variety next morning. If the stamens are removed without altering the position of the pistil (Pl. IV, fig. 1, *C*) or injuring it in any way and pollen is applied the morning after the flower is emasculated (Pl. IV, fig. 1, *D*), in nine cases out of ten they will set seed; and if none of the anthers were ruptured in their removal, the resulting seedlings will have some of the characters of both parents. If the two parents have spotted seeds and the seed bearer, for instance, be the well-known variety New Era (Pl. IV, fig. 2, *A*) and the pollen bearer the equally well-known Whippoorwill variety (Pl. IV, fig. 2, *B*), the seeds resulting from the first-generation plants will have the markings of both parents on each seed, giving a beautiful example of crossing in the seed itself. (Pl. IV, fig. 2, *C*.) In the second generation we have a strange combination. About nine parts of the resulting seeds are like those of the first generation, three parts like Whippoorwill, three parts like New Era, and one part self-colored, resembling the lighter or ground color of the straight Whippoorwill seeds; but in the first three lots, although the series are easily classed, there are upward of 30 variations in color alone, and many more when we take form and size into consideration. In subsequent generations they again vary until by following defined rules we get new fixed types.

However, the variations in cowpea crosses are not always so very apparent, especially when two varieties having seeds of the same color are selected as parents. While there are great differences in the other characters of the progeny, such as foliage, early and late ripening, vining habit, upright growth, and disease resistance, the seeds differ from the parents and among themselves apparently only in size and shape; and while in the first-mentioned cross one could pick out dozens of dissimilar seeds in the colors alone, three or four variations in size and shape are about all that the operator may expect from crossing varieties the seeds of which are similar in color but vary in size.

In the condition of the mother plant at the time of pollination there is fortunately some choice which makes for a high percentage of successful pollinations. It will be found, especially with the cowpea, that young plants allowed to fruit in 5-inch pots set seed with greater certainty than will rampant-growing plants in large pots. Again, old plants in large pots break freely into growth, but not of a viny nature. This growth produces flowers in abundance, and pods form with great freedom either from their own pollen or when crossed with pollen from other varieties.

CROSSING IN LARGE AND SMALL NUMBERS.

A matter of importance in plant breeding and one which does not receive the attention it deserves from the practical breeder is the grouping of varieties into at least two classes for somewhat different treatment in crossing. In the first division all the plants we now call varieties, which come true from seed, no matter how they originated, may be termed artificial species. This division includes garden and field crops, such as lettuce, cabbage, and turnips; radishes and others of this family; onions and other plants of the same natural order; carrots, celery, parsley, and parsnips; the cereals: varieties of alfalfa, and many others which come true from seed and are only propagated sexually. With these there is no necessity for raising many individuals of the first generation. If the breeder succeeds in getting a desirable cross between two well-defined kinds, a few individuals of the first generation are enough, provided the work of emasculation or depollination and the application of pollen to the flower so treated is not carried out in a perfunctory manner. The individuals of the second generation, if they are sufficiently numerous, will give the variations from which to choose selections for perpetuating.

The second great division includes those plants which do not come true from seed or at least have never been bred to reproduce in that manner. The treatment in crossing is different from that which should be accorded the sexually propagated varieties, in that large numbers of the first generation are necessary, so that the chances of securing improved forms will be greater in proportion to the number of seedlings raised from any one cross. Nearly all fruit and nut trees, grapevines, bush fruits, strawberries, and potatoes are included in this class; also many florists' flowers, such as roses, carnations, gladiolus, dahlia, fuchsia, chrysanthemums, and pelargonium. When the desired improvement is attained by crossing any two varieties, one plant of the improved form is sufficient to start with, and that is increased vegetatively, i. e., by cuttings, budding and grafting, layers, bulblets, cormlets, etc.

In this second division, when breeding improved forms by crossing is attempted we look for results in the first generation; consequently, the number of flowers pollinated must be large, so that the seed ripened will be in quantities large enough to give the necessary variation in the resulting seedlings. The plants mentioned above which are propagated asexually are all hybrids, crosses, or sports which have never been bred sufficiently to come true from seed; thus, when any two plants of distinct varieties are crossed we never can tell exactly what the progeny will be like, and it is as a rule so very varied that if we get one seedling in five thousand possessing characters superior to either parent we are doing well.

HYBRIDIZING SPECIES.

HELIANTHUS HYBRIDS.

It may be necessary at times to hybridize two natural species. If a hybrid is raised, the probabilities are that it will not set seed with its own pollen. This was the case in a hybrid recently raised between *Helianthus argophyllus* and *H. debilis*, the latter being the pollen-bearing parent. The plants, although subjected to the best treatment, did not set a single seed from their own pollen or from pollen applied from one flower head to the stigmas of another on the same plant; nor was a single seed set on a plant the flowers of which were pollinated with pollen taken from flowers on separate plants; but when a flower of the hybrid was pollinated with pollen from the male parent, seeds were produced freely. These when sown and the plants put in the open ground also seeded very abundantly; the flowers resulting from these seedlings were much finer than those of the parents or any of their forms. It remains to be seen, however, just how the third generation will turn out, as in the seedlings of this generation, now only a few inches high, the variation of the foliage is considerable.

GRASS HYBRIDS.

In hybridizing two species of grass lately the results obtained would indicate, in this instance at least, that large numbers of hybrid seedlings are not necessary in the first generation of grass hybrids. Out of 13 seeds secured, 10 germinated, and no two plants are alike; in fact, the variation in the progeny of the first generation is more marked than in any second-generation seedlings of any other cross between two varieties with which the writer is familiar. The parents were *Poa arachnifera* and *P. pratensis*, the latter being the pollen bearer. The seed bearer was a hermaphrodite plant and the only one out of about 400 seedlings.

The flowers of the seed bearer were thoroughly treated with water each morning until the crop of stamens was exhausted. A very large quantity of pollen from *Poa pratensis* was secured by cutting half an armful of culms of *P. pratensis* when in bloom; these were put in a vessel of water in the evening. Next morning the stigmas of *P. arachnifera* were thoroughly pollinated by taking one handful at a time of the culms of *P. pratensis* and shaking them over the depollinated stigmas of the Texas bluegrass. This was done in a greenhouse; the stigmas were almost hidden by the pollen. Only 13 seeds resulted, but these were more than enough, as each of the progeny might well have been taken for a new species.

Each of the 10 seedlings was propagated by division and 100 plants of each put out in the field. No seeds were produced, as the pollen was imperfect; not a single grain was found in good condition.

Pollen from *Poa pratensis* was again applied in 1908, and the plants seeded abundantly. The resulting seedlings are exceedingly varied. Some have long, broad leaves; others short and broad, narrow and short, or narrow and long leaves.

CROSSING CULTIVATED VARIETIES ON NATURAL SPECIES.

PANSIES.

To show what might be expected in renewing the vigor of some varieties by crossing them on wild progenitors, it may be permissible to mention some work in the improvement of the common pansy in an attempt to enable it to better withstand our hot summers. Some time ago a number of plants of *Viola tricolor* were found growing luxuriantly in southern California in hot and dry places. Even far down in the Imperial Valley, where the temperature frequently reaches a stage unheard of in the East, the plants seemed at home.

The idea suggested itself that this plant might be of use in imparting heat-resistant characters to the cultivated pansies. Plants were raised from the seed gathered and pollen from a strain of pansies applied to the stigmas of the wild plants. Some of the flowers of the first-generation progeny are shown in Plate XIV. The petals were removed from the flowers of the wild plant and their stigmas cleared of pollen with the aid of water previous to pollinating. All the plants secured have fair-sized flowers, more or less resembling in color and markings those of the wild type. The foliage more closely resembles the mother than it does the father. Recrossing with pollen from a good strain the present season will probably give the desired size next season.

DAHLIAS.

The original Twentieth Century dahlia was used in pollinating a new species from Mexico four years ago. This species has very small, bright-red flowers, and the stems are exceedingly long. The larger and very rough leaves are produced near the crown of the plant, leaving the principal stems with only very small leaves. The flowers of the Mexican plant were depollinated (Pl. V, figs. 1 and 2) and pollen applied to three of the flowers. Sixteen seedlings resulted; the small number of seeds was probably due to the fact that the mother plants were growing in small pots in the greenhouse and did not flower till after the outdoor crop had been blackened by frost. The pollen was obtained from flowers which had been saved and kept in water.

The resulting first-generation seedlings were strictly intermediate between the parents, all of them with very long stems (see Pl. XV), but the varieties were not striking enough in color or size of flower to warrant vegetative propagation. The best of them were bagged and allowed to set seeds. The seedlings of the following season gave a very large assortment of forms, and the colors were more varied than those of the first generation. About fifty forms were saved for further crossing and selection. The following summer the best of these were crossed with pollen from the cactus and other varieties. As a result a few crosses were produced which show that varieties may be raised in this way with large and well-formed flowers, some of them equal in these respects to some of our best varieties bred from plants in cultivation for nearly a century. One of the forms with single flowers is shown in Plate XV.

CROSS-POLLINATING CLOVERS.

To pollinate clover flowers artificially may seem a difficult operation on account of their minute and delicate structure, but in reality it is even more simple than the manipulation of the flowers of alfalfa. Many observations indicate that the flowers of the red clover are incapable of self-fertilization when protected from insects, as plants which have been tested with this end in view have in no case produced seeds. It would, however, seem that the emasculation of clover flowers is unnecessary, because when the keel is pulled forward and the stamens disturbed it rarely happens that the pollen comes in contact with the stigma.

When it is desired to perpetuate well-defined varieties by careful intercrossing of individuals, the work of transferring pollen from the anthers of one plant to the stigmas of another can be rapidly and effectively performed in the following manner: Select plants of both the proposed pollen and seed bearers which have developed flowers under the protection of a wire screen. We can then be reasonably certain of the absence of insect interference. Take a flower of the pollen bearer between the thumb and forefinger of the left hand, and using the forceps having a flattened pin tied to one end, as shown in figure 1, *C*, place the flat side of the pin parallel with the standard of a floret, the pin pointing to the base of the keel, and draw it gently upward. The result will be that many grains of pollen will adhere to the flattened portion of the pin. Turn the forceps in the hand so that the prongs take the position first held by the pin. This must be done carefully so as not to dislodge the pollen on the end of the pin. Then with the prongs of the forceps snip a piece from the end of the banner of the flower intended to be pollinated. This will show which of the flowers on a head have been manipulated. Next take one of the prongs of the forceps and bend down the keel and wings of the floret to be pollinated, securing them in a position under the end of the thumb. This operation will bring the upper part of the pistil into view. The forceps are now turned in the hand to their first position and the pollen carefully applied to the stigma. The operation is concluded by restoring the keel and wings to their original positions.

METHODS OF EMASCULATING AND POLLINATING COMMON FLOWERS.

THE ESSENTIAL ORGANS OF THE FLOWER.

In the greater number of flowering plants there are what are usually termed male and female organs in each flower. The rose (Pl. XI, figs. 1 and 2) and canna (Pl. IX, fig. 2, *A*, *B*, and *C*) are familiar examples. These are called hermaphrodite flowers.

Other plants have the male and female organs in separate flowers, but on the same plant, as in the begonias (Pl. XII, fig. 1) and the genus Codiaeum (Pl. XII, fig. 2). Flowers of this nature are termed monœcious.

There is still another class of plants which has the male flowers on one plant and the female flowers on another. Examples of this arrangement are found in the willows (Pl. XIII, fig. 1), the aucuba, the genus Nepenthes, and commonly in the edible asparagus (Pl. XIII, fig. 2). These flowers are termed diœcious.

The so-called male organs are the stamens (Pl. XI, fig. 1, *Sta*), usually consisting of the filaments, or stalks, and the anthers containing the powdery material, or pollen. The so-called female organ is the pistil (Pl. XI, fig. 1, *P*). The lower part is the ovary (Pl. IX, fig. 2, *a*, *o*); the next part, in some flowers absent, is known as the style (Pl. III, *E* and *F*). The terminal part, that on which the pollen is deposited, is the stigma (Pl. III, *E* and *F;* Pl. IX, fig. 2, *S*).

PREPARATION OF FLOWERS TO BE POLLINATED.

In crossing plants which have both male and female organs present in the same flower (Pl. XI, fig. 1) the principal point to be kept in view is the removal of the anthers from the flower which is chosen as the seed bearer before the pollen is ripe; this is to prevent self-pollination of the flower. It is also necessary to prevent pollen from other flowers on the same plant or from flowers on other plants of the same variety or species gaining access to the stigma of the flower to be cross-pollinated. To this end it is always advisable to have isolated plants for seed bearers.

A few of the flowers or as many as can be conveniently worked at one time may be selected for crossing, and the others removed. The selected flowers should be covered with paper bags, or, better still, the whole plant if not too large may be covered with a small-mesh wire screen, which will effectually prevent pollination by winged insects.

In some plants the anthers of the flower intended to be used as the seed bearer must be removed when the flower is in the bud stage, as the stamens mature long before the pistil (see Pl. X, fig. 2). This operation in many cases necessitates the mutilation of the petals; therefore, emasculation in the bud stage should never be performed except in those cases where the anthers shed their pollen before the petals expand. Many plants shed their pollen only after the petals expand, as in the rose and the lily, and this is the safest time to remove the anthers provided the flowers have been protected against access of pollen to the stigmas.

In plants like *Tecoma grandiflora* the anthers dehisce long before the flower opens, but the lobes of the stigma are closed and do not open until the anthers of the same flower have shriveled. However, the pollen grains which lie in the tube of the flower might be brought into contact with the stigma; therefore, it is safest to remove the anthers before they open.

With some plants, such as the anthuriums, the stigmas are ripe several days before the pollen matures. In this case the anthers can not be removed, nor is there any necessity for their removal in crossing. The common plantain (*Plantago lanceolata*) (Pl. X, fig. 1) is another plant in which the pistil matures a short time before the stamens of the same flower, thus insuring cross-pollination.

Those plants which have the stigmas and the stamens in separate flowers on the same plant, as in the genus Begonia and the genus Codiaeum (Pl. XII, figs. 1 and 2), should have the staminate flowers removed before they open and the pistillate flowers inclosed in small manila paper bags both before and after pollination, or if the proposed seed bearers are growing in pots they should be isolated and screened.

With plants which have pistillate flowers on one plant and staminate ones on another, as in the genus Nepenthes, willows (Pl. XIII, fig. 1), and asparagus (Pl. XIII, fig. 2), it is only necessary to guard against undesirable pollen by bagging the flowers before and after pollination.

REMOVAL OF THE ANTHERS.

The removal of the anthers in the case of flowers having both stamens and pistils is called emasculation. There are various ways in which the anthers may be removed. Perhaps the best method is to use the forceps shown in figure 1, *C*, as the most delicate stamens may be seized and their anthers removed with this instrument. When all the stamens are visible to the eye the process is an easy one. When, however, the operator wishes to emasculate a flower of a legume (Pl. IV, fig. 1) or of any other plant in the bud stage, he should know the number of stamens in the flower of each species, and the anthers should be counted as they are removed, thus making certain of the complete emasculation of the flower.

SECURING POLLEN.

To have the pollen of a flower to be used in pollinating absolutely pure, it is necessary that the stamens be protected, both before and after dehiscing, by the use of paper bags. To secure pollen in sufficient quantity to make certain that the stigmas of the proposed seed bearer are well covered, the best method is to secure a few flowers just before the anthers open, with stems long enough to go into a vessel of water. Let the vessel containing the flowers stand indoors until the stamens dehisce; then hold that part of the flower on which the stamens are situated over a watch glass and gently agitate the stamens with a pin. The pollen from a few flowers—of the rose, for instance (Pl. XI, fig. 2, *A*)—will fall in sufficient quantity to cover the glass. Then place the glass in a small box so that it may safely be carried from place to place. Some flowers have pollen which can not well be treated in this manner because it clings together in masses, as in the cowpea and the lily.

APPLYING THE POLLEN TO THE STIGMA.

In those flowers having pollen which clings together and adheres to the stamens the pollen is best applied to the stigmas directly from the stamens by means of the flattened pin shown in figure 1, *C*. Pollen such as that of the rose should never be applied with a dry brush unless there is a large quantity available, as this method means the loss of a very large percentage of the grains. In carrying the pollen from the glass to the stigma the least jar or movement of the air causes it to fall from the brush.

The most satisfactory method of transferring dry pollen is to use a very small brush prepared in the following manner: Dip the hairs in a weak sirup of sugar and water, draw them between the finger and thumb to remove the surplus moisture and to flatten the mass of hair, clip off a small portion of the ends so that the hairs will be all of one length, and trim the sides, which will result in the hairs sticking together. While still damp push the end of the flattened brush among the pollen grains, and even the driest pollen will adhere in masses. It is thus abundantly and easily applied to the most delicate stigmas. The experienced breeder can tell at a glance when the stigma of any flower is ready to be pollinated. The stigmas of the rose shortly after the petals expand indicate the receptive condition, and this may be taken as a guide for the stigmas of most flowers.

DESCRIPTION OF PLATES.

Plate I. Fig. 1.—Staminal tubes and stigmas of lettuce flowers (enlarged 20 diameters): *A*, Staminal tube; *B*, stigma appearing through end of tube; *C*, stigma covered with pollen; *D*, stigma depollinated. Fig. 2.—Depollinating lettuce flowers with water from a garden hose.

Plate II. Fig. 1.—Flowers of alfalfa (enlarged 5 diameters), showing the method of depollinating and crossing used: *A*, Untripped and unpollinated flower; *B*, tripped and self-pollinated flower; *C*, flower showing sexual column tripped against a pin, to prevent self-pollination and to provide the opportunity for depollination; *D*, depollinated flower; the operation is performed by training a jet of water on the sexual organs while the column is resting on the pin; *E*, flower showing the stigma pollinated with pollen from the flower of a distinct variety or species while the column is still resting on the pin; *F*, flower from which the pin has been withdrawn after pollination, allowing the stigma to press against the surface of the banner. Fig. 2.—Raceme of alfalfa flowers (enlarged 6 diameters). This illustration shows that when the column of the flower is tripped the pressure is sufficient to hold a small pin.

Plate III. Sexual columns of alfalfa flowers (enlarged 10 diameters), showing different stages of development: *A* and *B*, Columns with anthers just before the dehiscing stage; *C* and *D*, columns with anthers dehisced; *E* and *F*, columns with pollen and empty anthers removed by the aid of water previous to artificial pollination.

Plate IV. Fig. 1.—Flowers and young pods of the cowpea (twice natural size): *A*, Flower bud showing condition on the evening of the day previous to the opening of the flower; *B*, flower in the bud stage, showing how the floral envelope is opened to gain access to the stamens for emasculation; *C*, flower with stamens removed, showing the large stigma to the left; *D*, emasculated flower the next morning after pollination; *E*, young pod the second morning, showing that fertilization has been accomplished; *F*, the same pod forty-eight hours after the pollination of the flower. Fig. 2.—Seeds of cowpea parents and of a first-generation cross (enlarged 2½ diameters). *A*, New Era; *B*, Whippoorwill; *C*, New Era ♀ × Whippoorwill ♂.

Plate V. Fig. 1.—*Dahlia chisolmii* (enlarged 4 diameters), showing disk florets before depollination. The stigmas are densely covered with pollen. Fig. 2.—*Dahlia chisolmii* (enlarged 4 diameters), showing disk florets after depollination by a jet of water.

Plate VI. Fig. 1.—Disk florets of the greenhouse cineraria before depollination (enlarged 5 diameters), showing the stigmas covered with pollen. Fig. 2.—Disk florets of the greenhouse cineraria (enlarged 5 diameters) after depollination with water.

Plate VII. Fig. 1.—Flower of dahlia (enlarged 5 diameters), showing the disk florets, the stigmas of which are nearly all covered with pollen. The stigmas of the inner florets are not fully developed. On these the pollen is very abundant. Fig. 2.—The dahlia flower (enlarged 5 diameters) shown in figure 1, with the outer florets depollinated by a jet of water. The stigmas of the inner florets are not fully developed.

Plate VIII. Fig. 1.—Dahlia florets (enlarged 10 diameters), showing development of the stigmas: *A*, Unopened disk floret; *B*, floret after the staminal tube enveloping the stigma has appeared above the corolla; *C*, floret with the stigma partly protruding from the staminal tube; at this stage it is thickly covered with pollen; *D*, floret with the stigma still farther advanced; the upper part of the staminal tube is seen near the base of the stigma; *E*, floret with the stigma fully developed and covered with pollen; *F*, floret with the stigma depollinated with water. Fig. 2.—Dahlia florets (enlarged 6 diameters), before and after depollination: *A*, Disk florets, showing the stigmas covered with pollen; the staminal tubes have been pulled within the corollas; *B*, florets with the stigmas depollinated by water.

Plate IX. Fig. 1.—Disk florets of Helianthus (enlarged 5 diameters), showing different stages of development: *A*, Floret in bud stage; *B*, floret, showing staminal tube inclosing stigma, the upper part covered with pollen; *C*, floret (twenty-four hours later), showing the stigma covered with pollen and the staminal tube partly drawn within the corolla; *D*, floret with the stigma depollinated; this is done when the floret has reached the stage shown in *B*. Fig. 2.—Flowers of *Canna indica* (natural size), showing stamen and pistil in different stages of development. *Sta*, Stamen; *S*, stigma; *O*, ovary.

Plate X. Fig. 1.—Flowers (proterogynous) of *Plantago lanceolata*, showing pistils maturing before the stamens: *A*, Flower head, showing mature pistils; *B*, flower head, showing a few stamens to the right; C, flower head, showing withered stamens at the base of the flower spike; *D*, flower head in a more advanced stage. Fig. 2. Flower (proterandrous) of *Campanula rotundifolia* (enlarged 3 diameters), showing stamens maturing before the pistil. *A*, Flower bud; *B*, flower bud with corolla removed, showing large, mature stamens encircling the immature pistil; *C*, flower with portion of corolla removed; the stigma is still immature, the anthers have discharged their pollen, and the stamens are wilted and curled around the base of the style; *D*, flower after the corolla has withered and the stigma has expanded.

Plate XI. Fig. 1.—Single tea rose, showing how easily hermaphrodite flowers having large stamens may be emasculated: *Sta*, Stamens; *P*, pistils. Fig. 2.—Flowers of roses (natural size), showing method of emasculation: *A*, Flowers with petals removed, showing stamens and pistils; *B*, flowers with stamens removed, showing stigmas ready to be pollinated.

Plate XII. Fig. 1.—Flowers (monœcious) of begonia, showing the sexes in different flowers on the same plant: *A*, *A*, Pistillate flowers; *B*, *B*, staminate flowers. Fig. 2.—Staminate and pistillate flowers of *Codiacum variegatum* from the same plant. *A*, Male flowers; *B*, female flowers.

Plate XIII. Fig. 1.—Staminate and pistillate (diœcious) flowers of willow from different plants: *A*, Female flowers; *B*, male flowers. Fig. 2.—Flowers from staminate and pistillate plants of *Asparagus officinalis* (enlarged 5 diameters): *A*, Pistillate flowers; *B*, staminate flowers.

Plate XIV. Flowers from first-generation seedlings of crosses of pansies (natural size). *Viola tricolor* ♀ × cultivated forms ♂. The row of flowers at the bottom is *V. tricolor* uncultivated.

Plate XV. Single branch of hybrid dahlia plant. *Dahlia chisolmii* ♀ × Twentieth Century dahlia ♂. Height of branch 7 feet 6 inches, showing very large compound leaves near the base and long flowering stems.

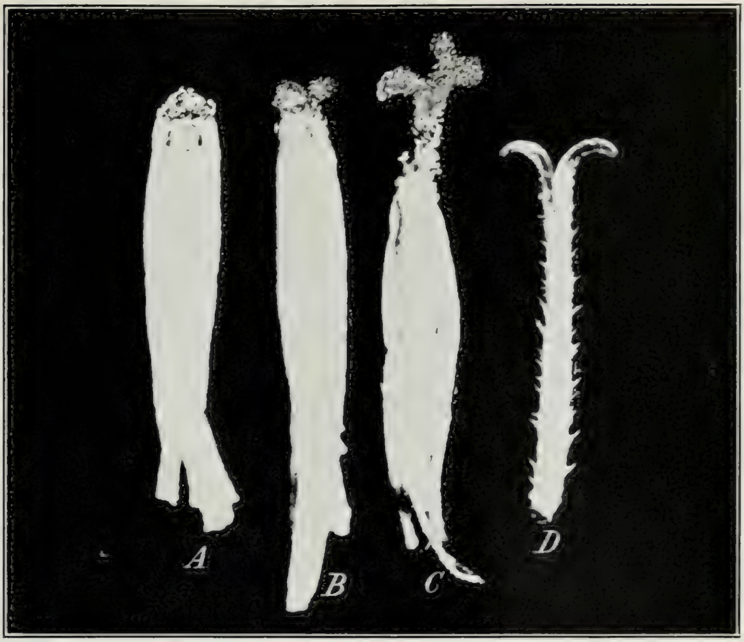


FIG. 1.—STAMINAL TUBES AND STIGMAS OF LETTUCE FLOWERS (ENLARGED TWENTY DIAMETERS).

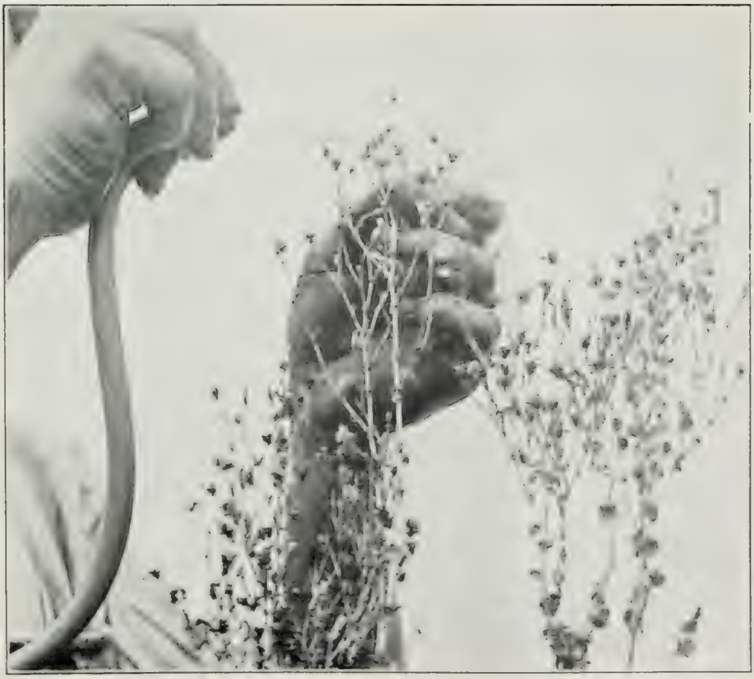


FIG. 2.—DEPOLLINATING LETTUCE FLOWERS WITH WATER FROM A GARDEN HOSE.

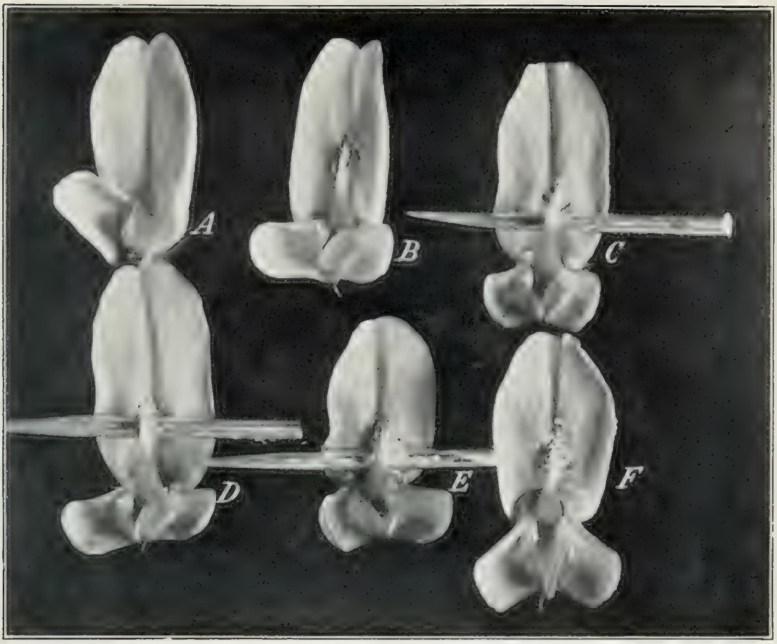


FIG. 1.—FLOWERS OF ALFALFA (ENLARGED FIVE DIAMETERS), SHOWING THE METHOD OF DEPOLLINATING AND CROSSING USED.

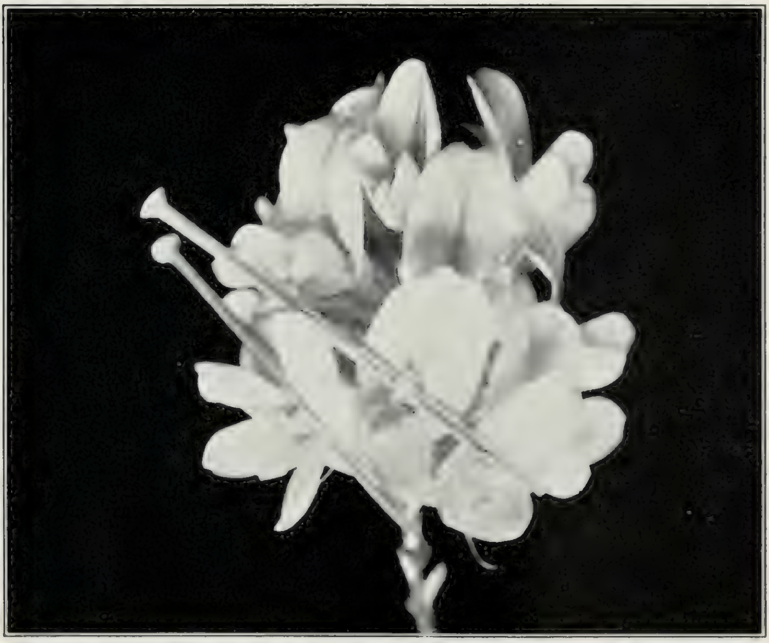
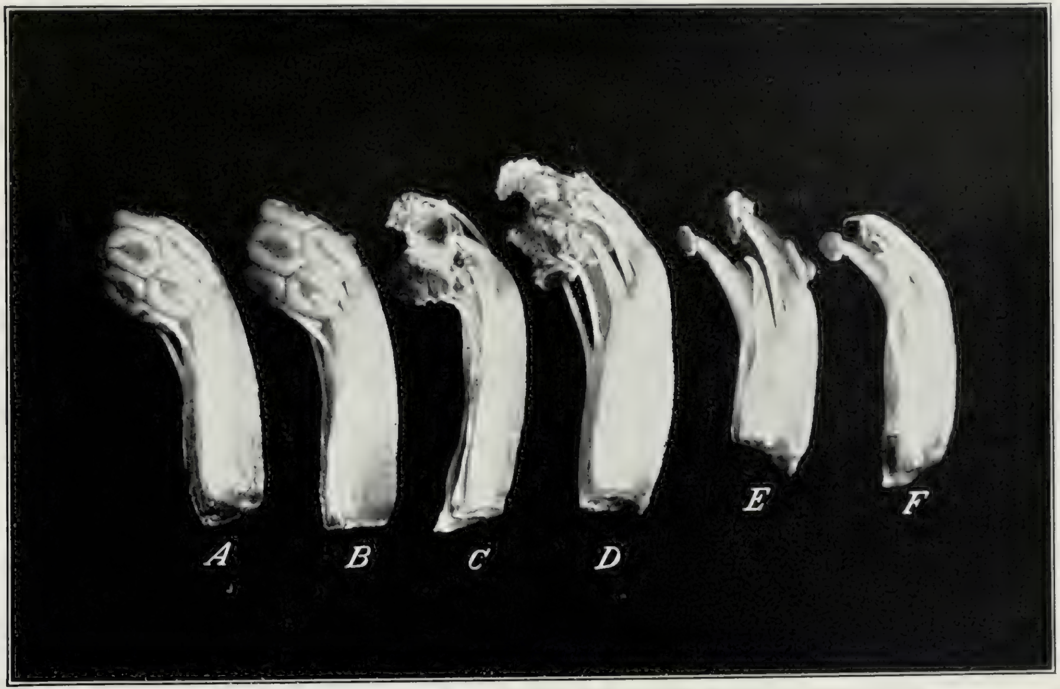


FIG. 2.—RACEME OF ALFALFA FLOWERS (ENLARGED SIX DIAMETERS).



SEXUAL COLUMNS OF ALFALFA FLOWERS (ENLARGED TEN DIAMETERS), SHOWING DIFFERENT STAGES OF DEVELOPMENT.

A and *B*, Columns with anthers just before the dehiscing stage; *C* and *D*, columns with anthers dehisced; *E* and *F*, columns with pollen and empty anthers removed by the aid of water previous to artificial pollination.

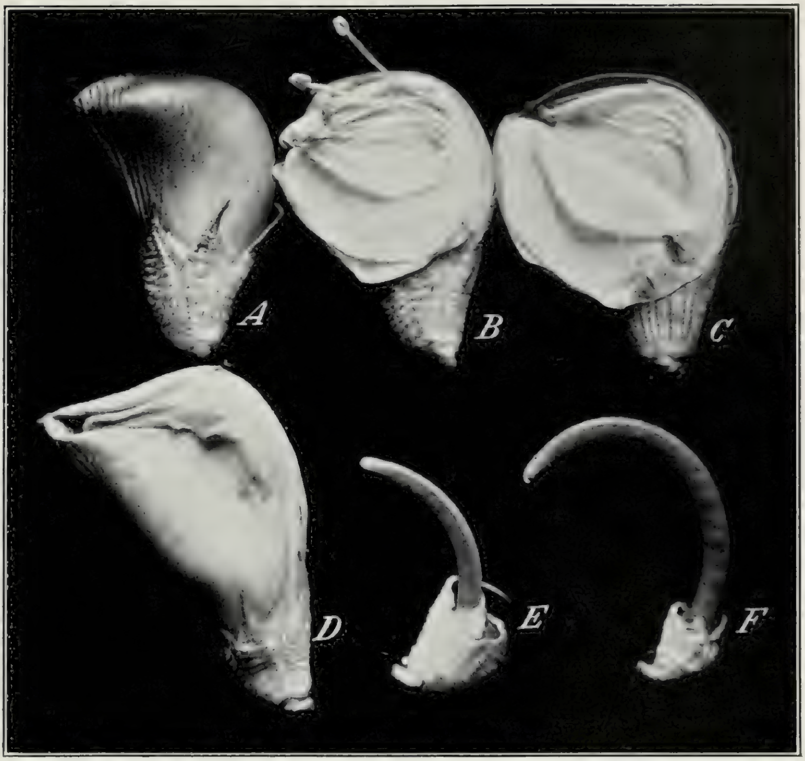


FIG. 1.—FLOWERS AND YOUNG PODS OF THE COWPEA (TWICE NATURAL SIZE).

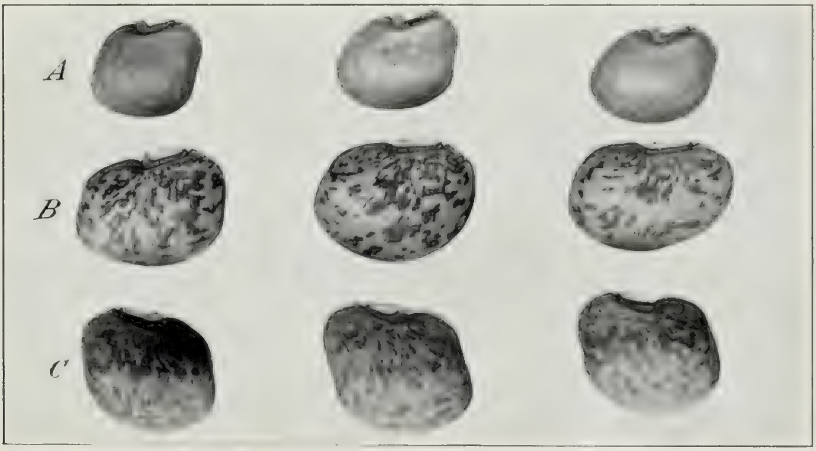


FIG. 2.—SEEDS OF COWPEA PARENTS AND OF A FIRST-GENERATION CROSS (ENLARGED TWO AND ONE-HALF DIAMETERS).

A, New Era; *B*, Whippoorwill; *C*, New Era ♀ × Whippoorwill ♂.

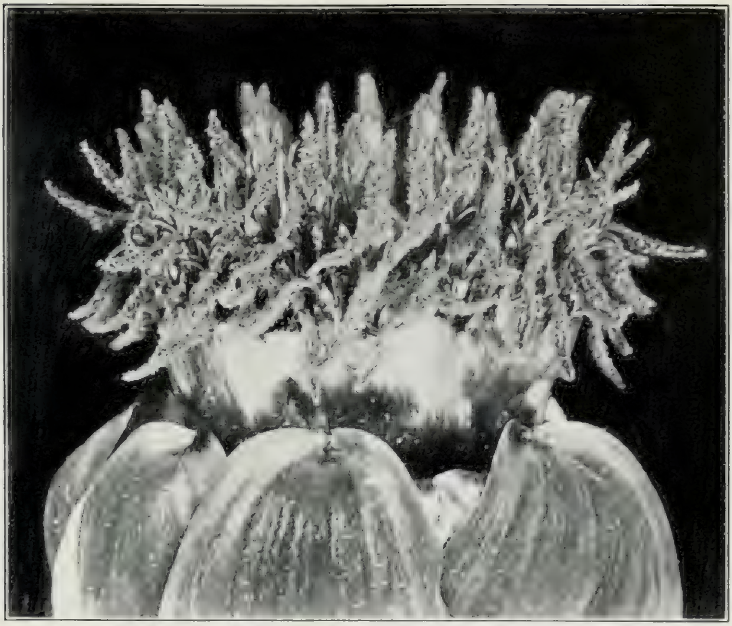


FIG. 1.—DAHLIA CHISHOLMII (ENLARGED FOUR DIAMETERS), SHOWING DISK FLORETS BEFORE DEPOLLINATION.

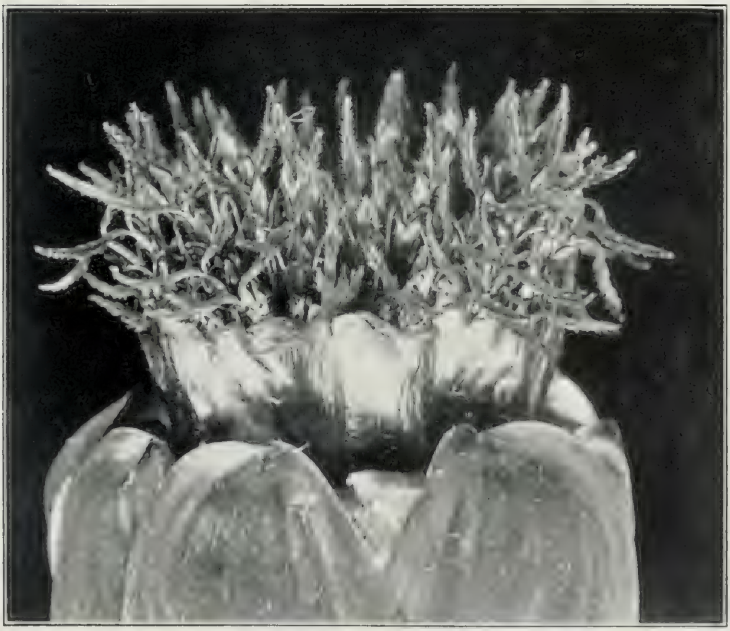


FIG. 2.—DAHLIA CHISHOLMII (ENLARGED FOUR DIAMETERS), SHOWING DISK FLORETS AFTER DEPOLLINATION BY A JET OF WATER.

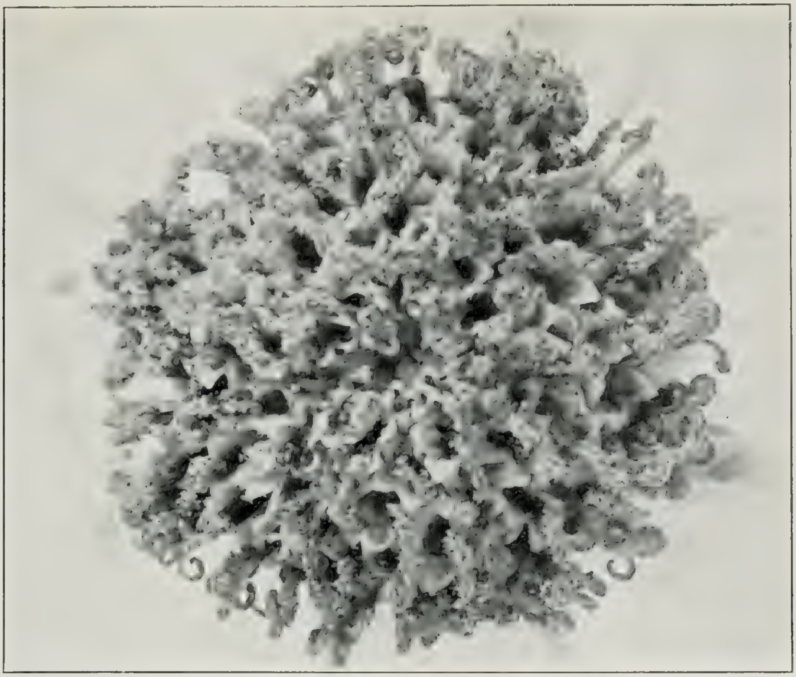


FIG. 1.—DISK FLORETS OF THE GREENHOUSE CINERARIA BEFORE DEPOLLINATION (ENLARGED FIVE DIAMETERS).

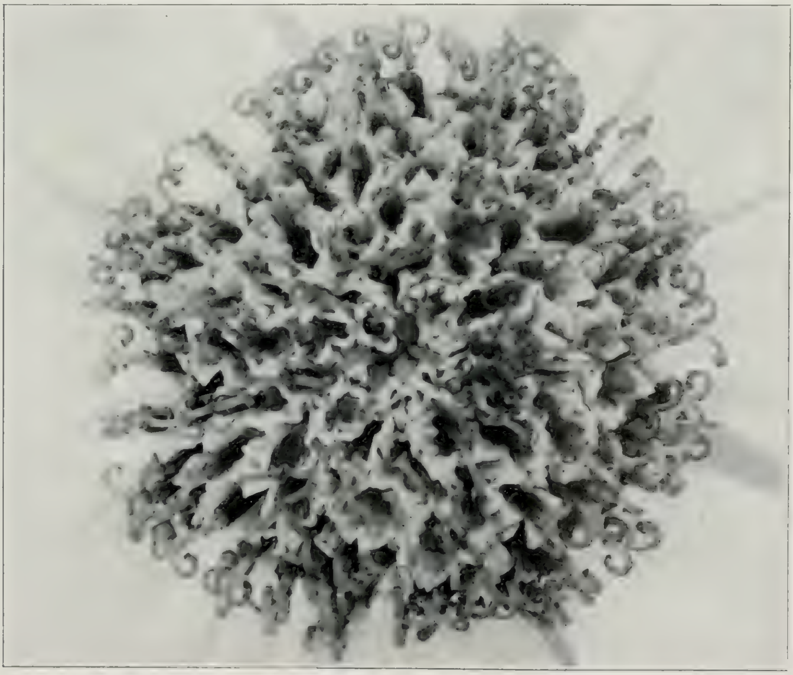


FIG. 2.—DISK FLORETS OF THE GREENHOUSE CINERARIA AFTER DEPOLLINATION (ENLARGED FIVE DIAMETERS).

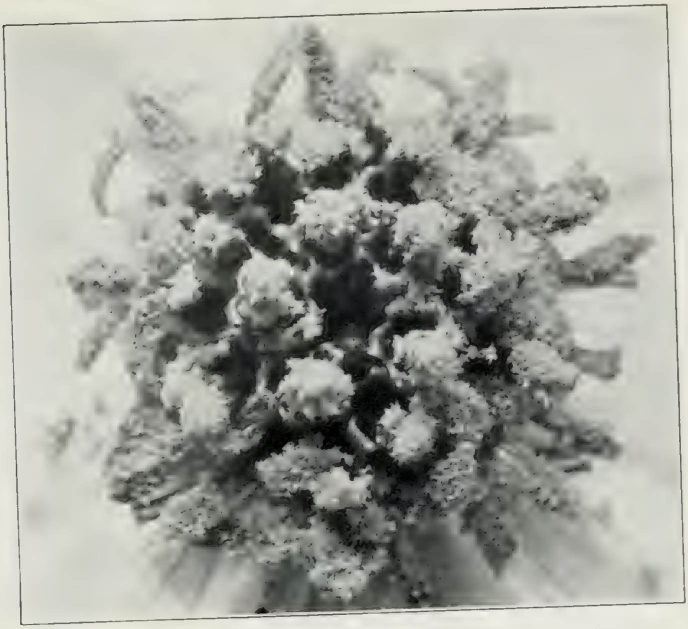


FIG. 1.—FLOWER OF DAHLIA (ENLARGED FIVE DIAMETERS), SHOWING THE DISK FLORETS, THE STIGMAS OF WHICH ARE NEARLY ALL COVERED WITH POLLEN.

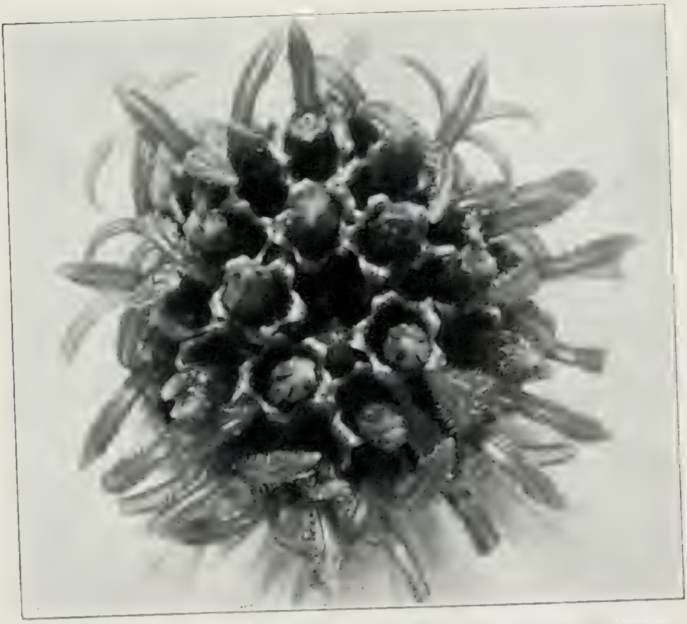


FIG. 2.—THE DAHLIA FLOWER (ENLARGED FIVE DIAMETERS) SHOWN IN FIGURE 1, WITH THE OUTER FLORETS DEPOLLINATED BY A JET OF WATER.

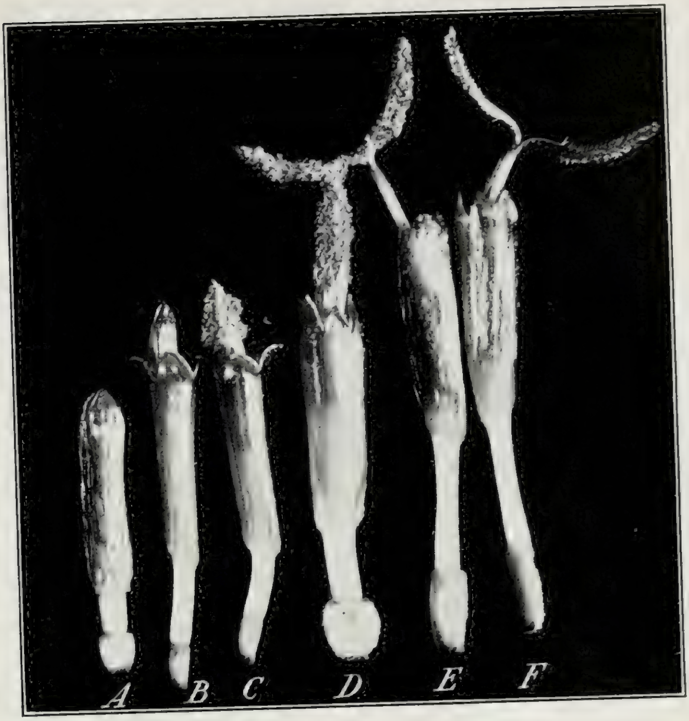


FIG. 1.—DAHLIA FLORETS (ENLARGED TEN DIAMETERS), SHOWING DEVELOPMENT OF THE STIGMAS.

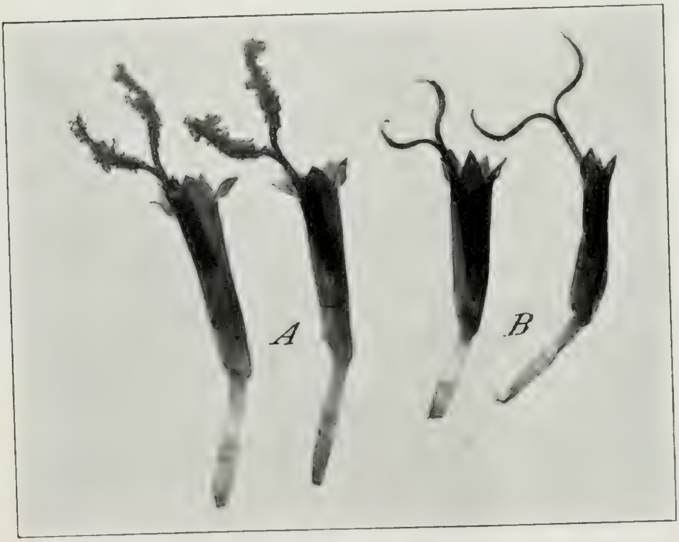


FIG. 2.—DAHLIA FLORETS (ENLARGED SIX DIAMETERS), BEFORE AND AFTER DEPOLLINATION

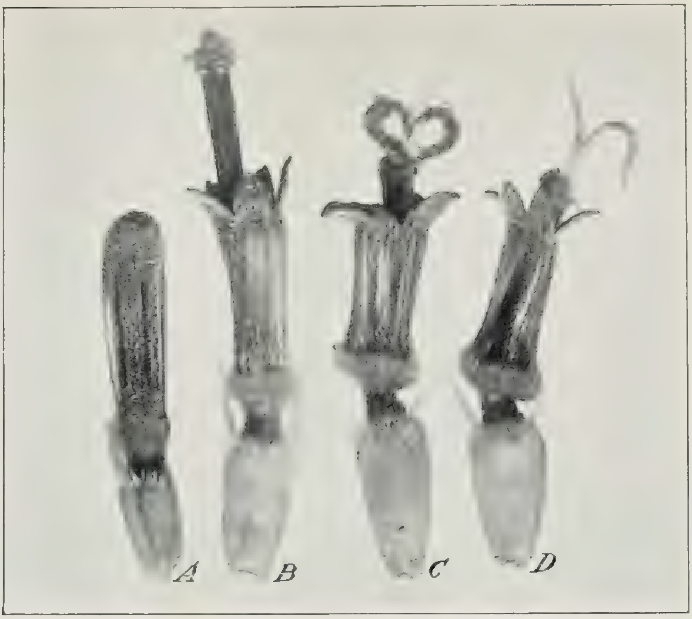


FIG. 1.—DISK FLORETS OF HELIANTHUS (ENLARGED FIVE DIAMETERS), SHOWING DIFFERENT STAGES OF DEVELOPMENT.

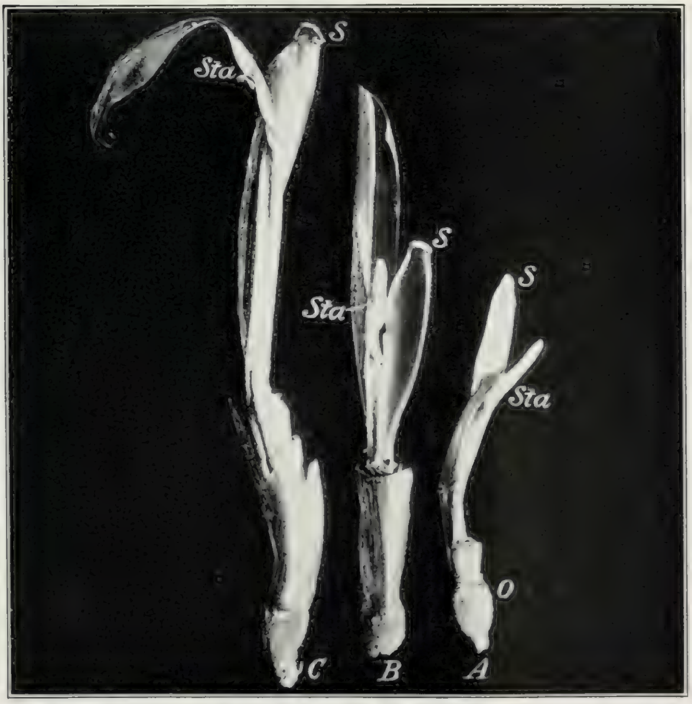


FIG. 2.—FLOWERS OF CANNA INDICA (NATURAL SIZE), SHOWING STAMEN AND PISTIL IN DIFFERENT STAGES OF DEVELOPMENT.

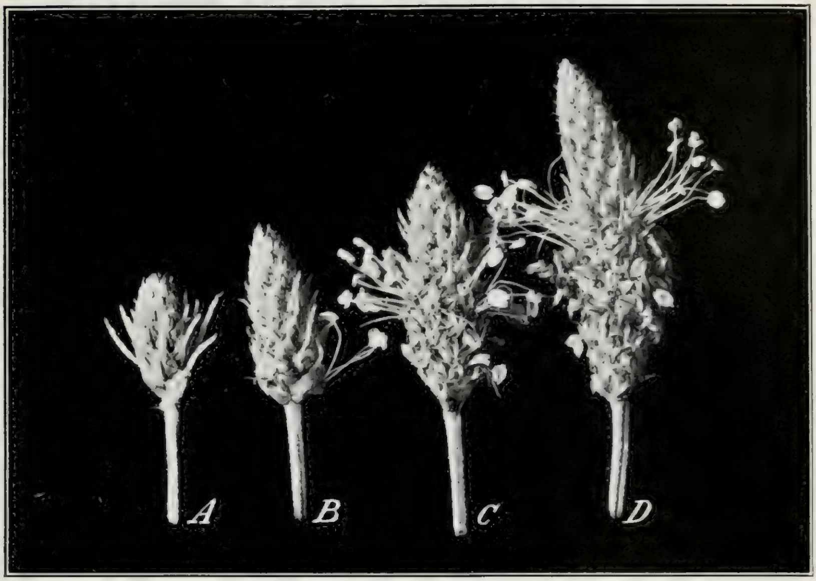


FIG. 1.—FLOWERS (PROTEROGYNOUS) OF PLANTAGO LANCEOLATA, SHOWING PISTILS MATURING BEFORE THE STAMENS.

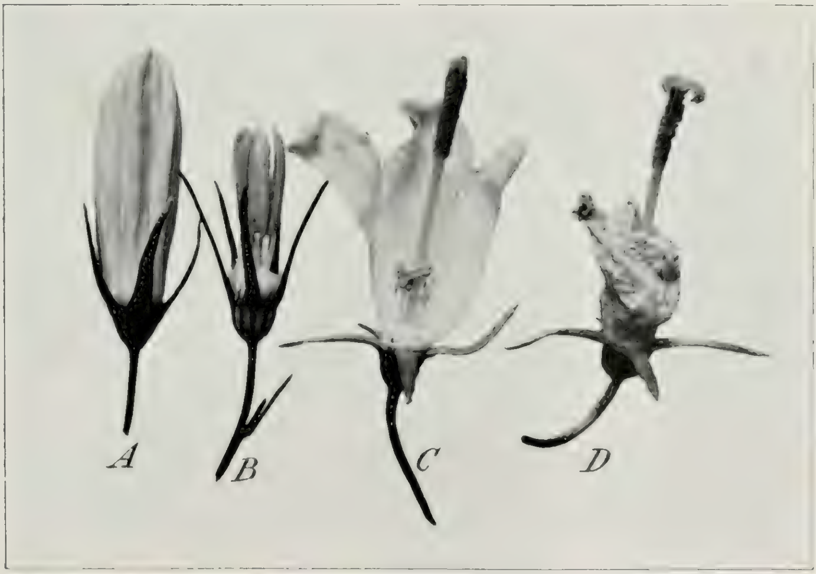


FIG. 2.—FLOWER (PROTERANDROUS) OF CAMPANULA ROTUNDIFOLIA (ENLARGED THREE DIAMETERS), SHOWING THE STAMENS MATURING BEFORE THE PISTIL.

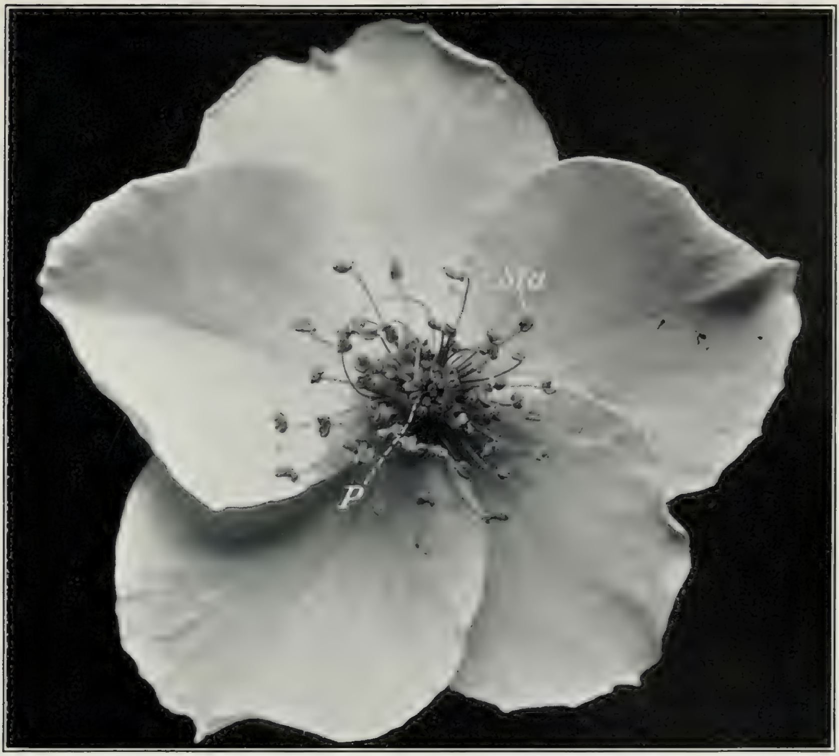


FIG. 1.—SINGLE TEA ROSE, SHOWING HOW EASILY HERMAPHRODITE FLOWERS HAVING LARGE STAMENS MAY BE EMASCULATED.

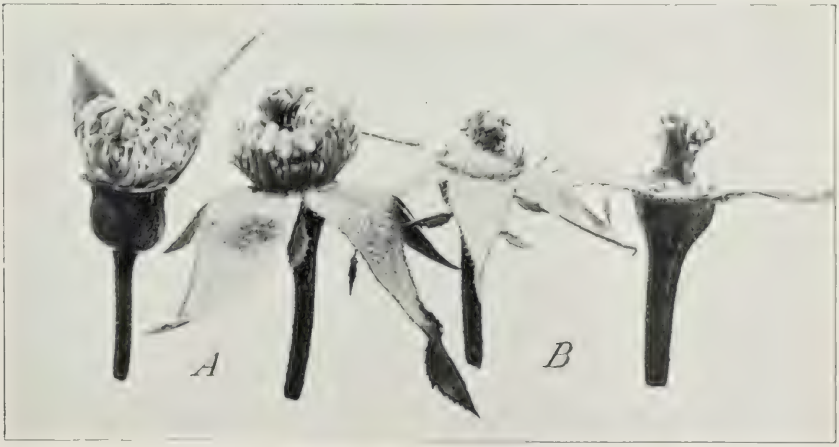


FIG. 2.—FLOWERS OF ROSES (NATURAL SIZE), SHOWING METHOD OF EMASCULATION.

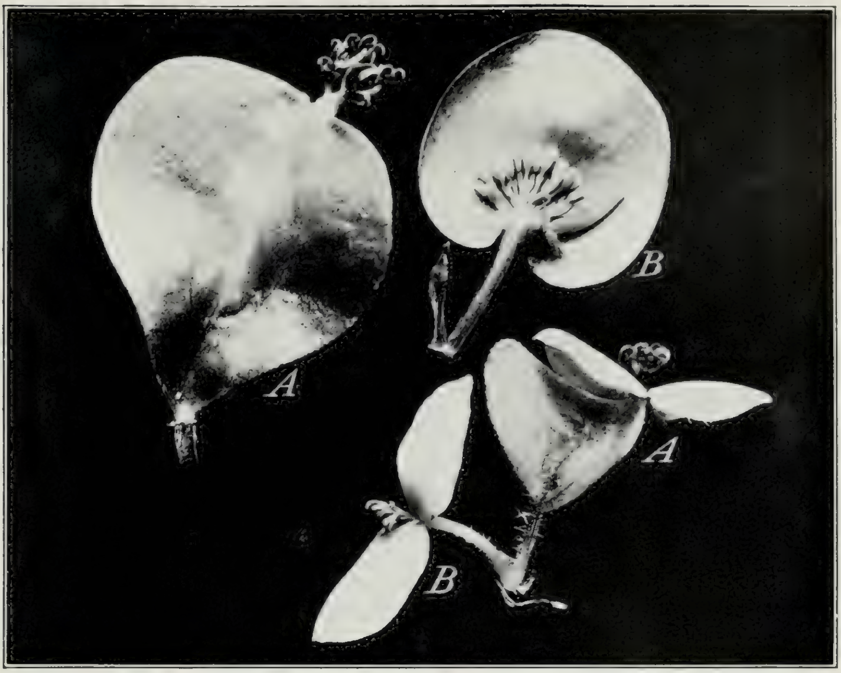


FIG. 1.—FLOWERS (MONŒCIOUS) OF THE BEGONIA, SHOWING THE SEXES IN DIFFERENT FLOWERS ON THE SAME PLANT.

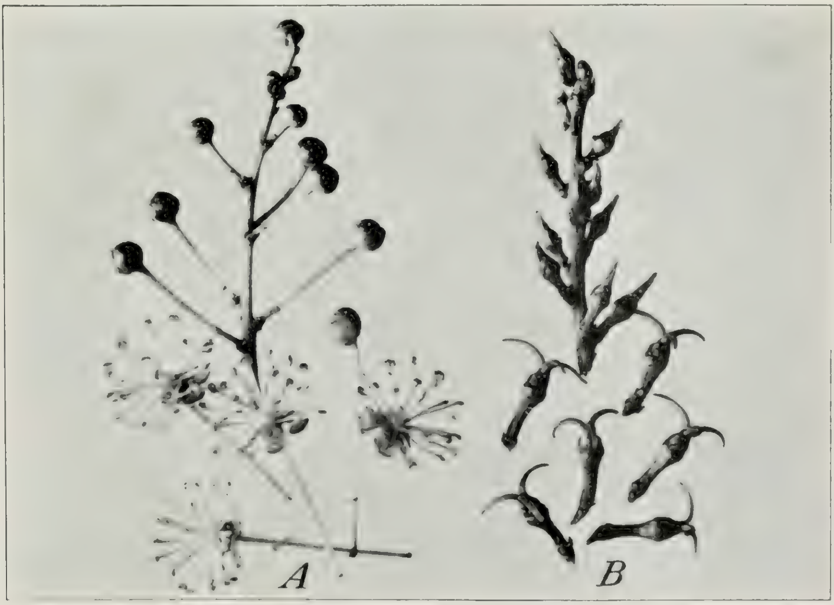


FIG. 2.—STAMINATE AND PISTILLATE FLOWERS OF CODIAEUM VARIEGATUM FROM THE SAME PLANT.

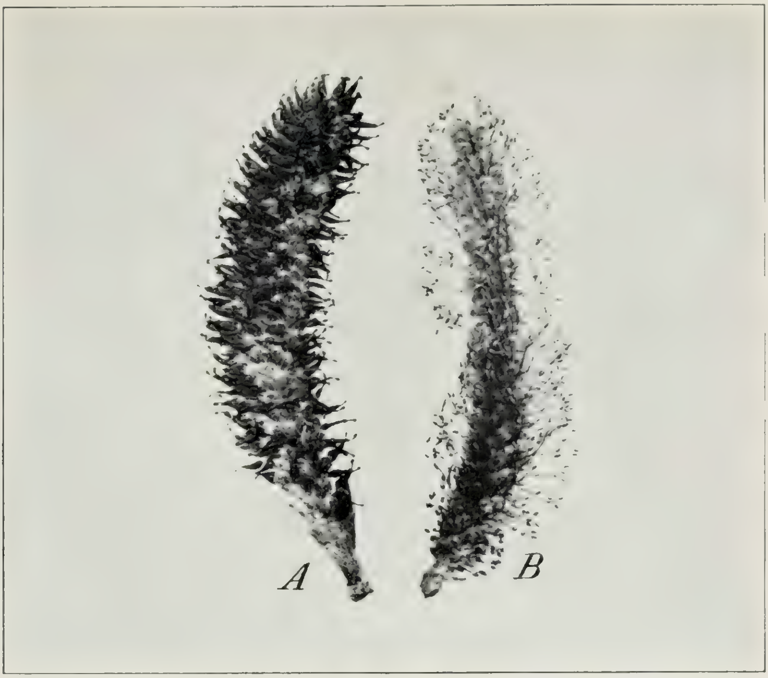


FIG. 1.—STAMINATE AND PISTILLATE (DIŒCIOUS) FLOWERS OF WILLOW, FROM DIFFERENT PLANTS.

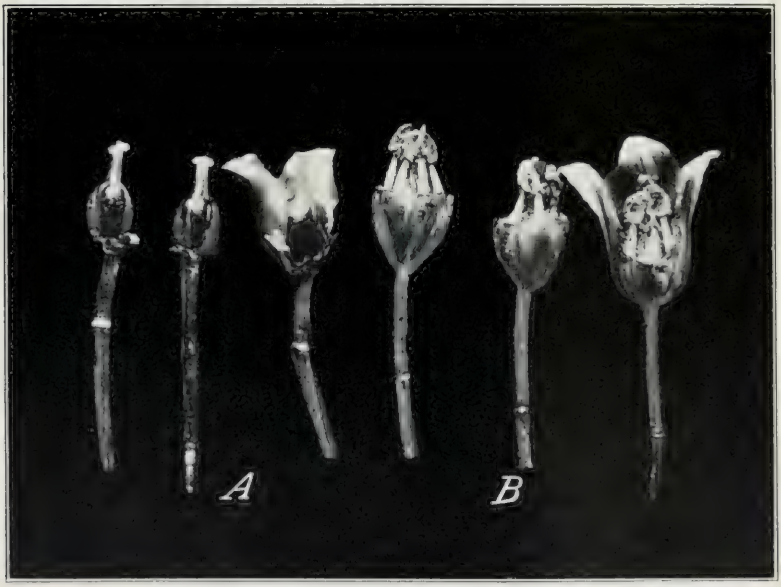
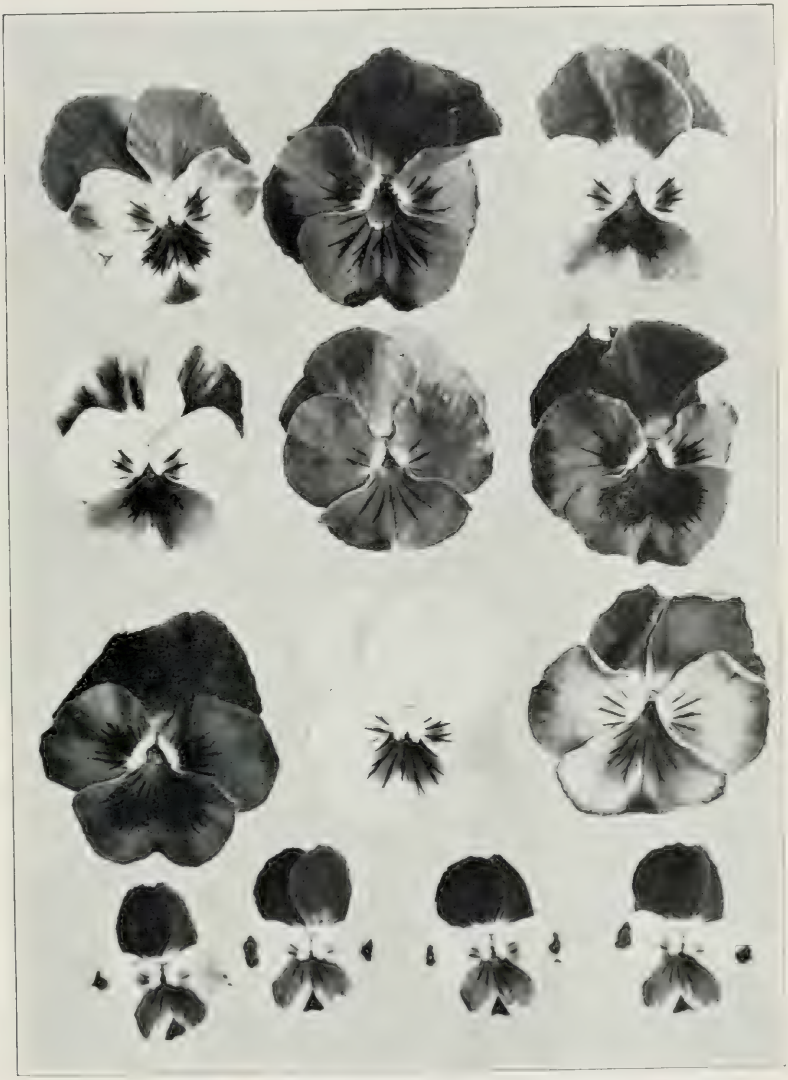
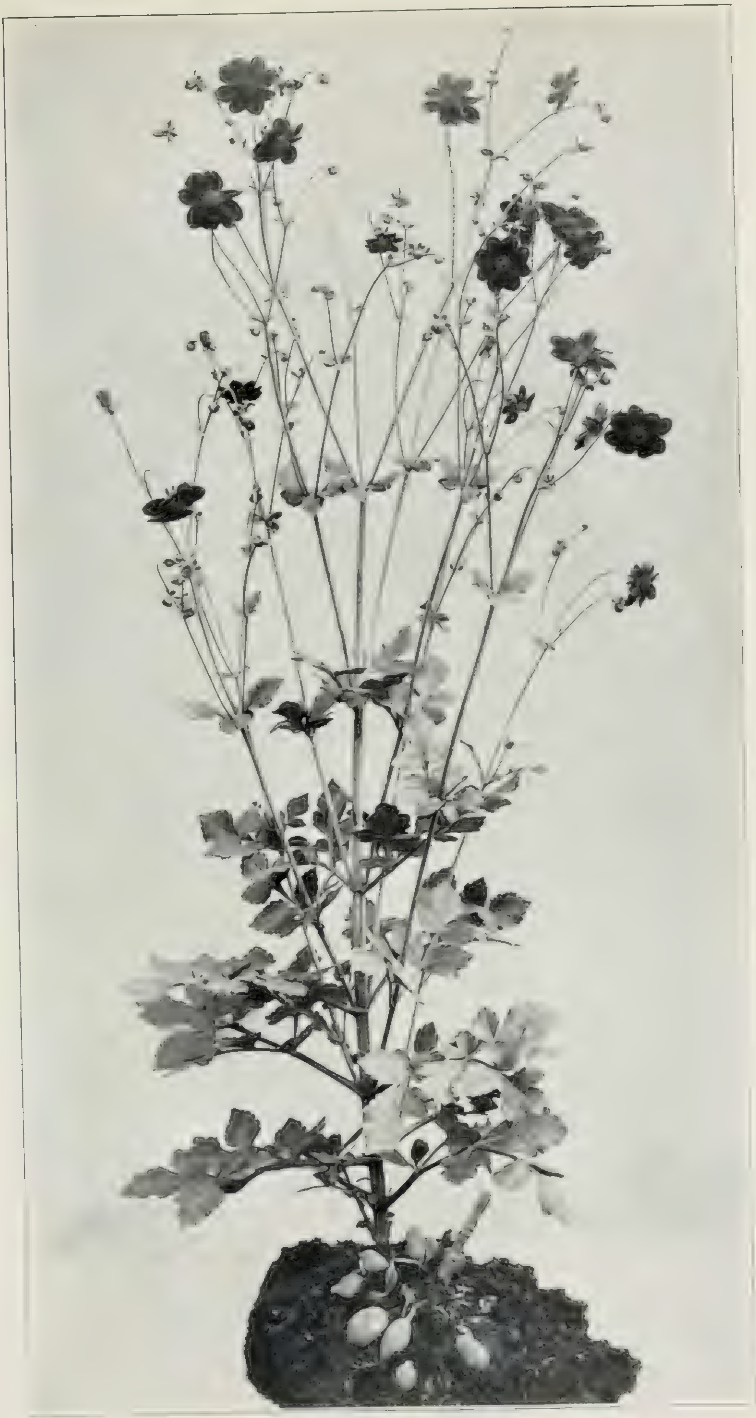


FIG. 2.—FLOWERS FROM STAMINATE AND PISTILLATE PLANTS OF ASPARAGUS OFFICINALIS (ENLARGED FIVE DIAMETERS).



FLOWERS FROM FIRST-GENERATION SEEDLINGS OF CROSSES OF PANSIES (NATURAL SIZE).

Viola tricolor ♀ × cultivated forms ♂. The row of flowers at the bottom is *Viola tricolor* uncultivated.



SINGLE BRANCH OF HYBRID DAHLIA PLANT.

Dahlia chisolmii ♀ × Twentieth Century dahlia ♂.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 168.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM APRIL 1 TO JUNE 30, 1909:

INVENTORY No. 19; Nos. 25192 to 25717.

Issued December 29, 1909.

239493
13.1.30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

BUREAU OF PLANT INDUSTRY.

Chief of Bureau, BEVERLY T. GALLOWAY.
Assistant Chief of Bureau, ALBERT F. WOODS.
Editor. J. E. ROCKWELL.
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FOREIGN SEED AND PLANT INTRODUCTION.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., October 1, 1909.

SIR: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 168 of the series of this Bureau the accompanying manuscript, entitled "Seeds and Plants Imported during the Period from April 1 to June 30, 1909: Inventory No. 19; Nos. 25192 to 25717."

This manuscript has been submitted by the Agricultural Explorer in Charge of Foreign Seed and Plant Introduction with a view to publication.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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B. P. I.—518.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM APRIL 1 TO JUNE 30, 1909: INVENTORY NO. 19; NOS. 25192 TO 25717.

INTRODUCTORY STATEMENT.

The material listed in this nineteenth inventory of seeds and plants imported was secured almost entirely through friends and correspondents abroad and by the efforts of coworkers in this country. No agricultural explorers were in the field during the time covered, although three varieties of alfalfa and one of clover secured by Professor Hansen in central Asia are included here, having arrived too late for the last inventory, and as this inventory goes to press Mr. Frank N. Meyer is on his way to Chinese Turkestan, where he goes in search of hardy fruits, forage crops, and grains.

The following are some of the more important items in this inventory:

A collection of named German and other European varieties of alfalfa (Nos. 25193, 25194, 25257, and 25264 and following numbers) has been secured for the work in Plant Life History Investigations.

Following the example of Louisiana and Hawaii, it is hoped that some valuable work can be done for the newly opened region in southern Texas with a fine collection of sugar-cane hybrids recently received at the South Texas Garden from the Harvard Botanic Station in Cuba (Nos. 25225 to 25242).

A remarkable eucalypt hybrid (No. 25246) which comes true from seed, an acquisition from Algeria, should be of value to growers of these trees in California.

A clover and three varieties of alfalfa, previously mentioned (No. 25276 and following numbers), were secured through Prof. N. E. Hansen on his central Asian journey, but arrived too late to be grouped with the forage crops described in the last inventory.

The specialists in cereals of the Department of Agriculture and the state experiment stations making oat trials will undoubtedly find some good material in the collections from Spain, Italy, and Roumania (No. 25317 and following numbers, No. 25351 and following numbers, and No. 25580 and following numbers).

Africa, the reputed home of the sorghum, has again contributed its quota for experiments in the Southwest in seventeen varieties from Togo (No. 25328 and following numbers).

A wild red raspberry (No. 25466) from the Philippines is considered a possibility for breeding a desirable form for the South or for our tropical possessions.

Mr. Husbands, of Limávida, Chile, has again sent the Department a collection of forest and ornamental trees and shrubs, together with forage crops and muskmelons adapted to the Pacific slope (No. 25470 and following numbers; No. 25611 and following numbers).

Another collection of muskmelons (No. 25538 and following numbers), consisting of extra-choice winter varieties adapted to California conditions, has been received from the American vice-consul at Valencia, Spain.

A curious rubber plant (No. 25547), only recently described, has been secured from Angola, West Africa. It is a slow-growing desert type in which the rubber is stored up in turnip-shaped underground roots. It will be used for trials in methods of rapid propagation and selection.

Nine varieties of rice from Trinidad (No. 25596 and following numbers) may prove valuable for the work of the Hawaii Agricultural Experiment Station.

Manchuria has contributed ten more varieties of soy beans (No. 25649 and following numbers) secured through the American consul at Newchwang.

Collections of cereals, legumes, and sorghums from Abyssinia (No. 25666 and following numbers) and tropical legumes from Bombay, India (No. 25704 and following numbers), have added materially to the list of plants available for trial in the South.

This nineteenth inventory contains 526 separate introductions, covering the quarter beginning April 1 and ending June 30, 1909. The material included was determined by Messrs. W. F. Wight and H. C. Skeels, while the manuscript was prepared by Miss Mary A. Austin.

DAVID FAIRCHILD,
Agricultural Explorer in Charge.

OFFICE OF FOREIGN SEED AND PLANT INTRODUCTION,
Washington, D. C., September 7, 1909.

INVENTORY.

25192. MEDICAGO SATIVA L. **Alfalfa.**

From Tulare, Cal. Grown by Mr. J. T. Bearss, of the agricultural substation. Presented by Director E. J. Wickson, through Mr. J. M. Westgate. Received April 1, 1909.

"This was grown from S. P. I. No. 1151, which was secured in Kopal, Siberia. It is considered to be the best variety of Turkestan alfalfa tested by the California experiment station. It has variegated flowers, as do commercial sand lucern, *Grimm* alfalfa, and several other hardy valuable strains." (*Westgate.*)

25193. MEDICAGO SATIVA L. **Alfalfa.**

From Bargen, Baden, Germany. Secured from Mr. Adam Joos, Bargen, near Sinsheim, Baden, through Mr. Charles J. Brand. Received April 1, 1909.

Alt-Deutsche Fränkische luzerne. "This seed was grown in the valley of the Elsenz, a tributary of the Neckar. It is the practice in this section to leave either the first or second growth for the seed. When the first is left, harvesting is done in August. Mr. Joos states that old stands serve better for seed-producing purposes than young. Concerning the old German variety he says: 'This variety of clover is at home with us; it has already been cultivated for centuries.'" (*Brand.*)

25194. MEDICAGO SATIVA L. **Alfalfa.**

From Bavaria, Germany. Secured from Gutsbesitzer Heil, Tückelhausen, near Würzburg, Bavaria, through Mr. Charles J. Brand. Received April 1, 1909.

Alt-Deutsche Fränkische luzerne. "(P. L. H. No. 3437.) In the section from which this seed was procured, lucern left for seed is cut with the scythe, bound by hand into small bundles, and shocked. The second cutting is always used for seed production." (*Brand.*)

25195. ACTINIDIA ARGUTA (S. & Z.) Planch.

From Taracol, Unsan, Korea. Presented by Mr. J. D. Hubbard, metallurgist for the Oriental Consolidated Mining Company. Received April 1, 1909.

"Seeds of the Korean 'tara,' or wild fig. In its wild state here the tara plant is a wonderfully tough and wiry vine that will climb up trees sometimes to a height of 30 feet. The fruit has a green skin and is the size of a date when ripe. The flavor is different from any fruit I ever tasted, and I come from California, the 'land of fruit.' I do not think the vines bear the first year, but after that profusely." (*Hubbard.*)

25196. CITRUS NOBILIS × AURANTIUM. **Orange.**

From Algiers, Algeria. Presented by Dr. L. Trabut, botanist to the Government of Algeria, through Mr. Walter T. Swingle. Received April 5, 1909.

Clémentine. Budsticks procured for grafting purposes.

"This new variety of tangerine orange is said to be very mild and to be a very bright red color. It was found in North Africa by Doctor Trabut and is considered by him to be a very promising novelty." (*Swingle.*)

25197. Stizolobium sp.

From Homestead, Fla. Presented by Mr. Thomas Brewer, through Mr. P. J. Wester, in charge, Subtropical Garden, Miami, Fla. Received April 2, 1909.

"I have originated a white velvet bean which has taken me four years to perfect from one lone white bean, and I think there is a great future for it, as this variety is good to eat cooked like lima beans, and four times as prolific. The beans seem to be more domesticated and a better strain than the old dog tick velvet beans, and I think will take their place entirely when introduced." (*Brewer.*) Similar to S. P. I. No. 24766.

25198 to 25203. Manihot spp. **Cassava.**

From Brazil. Presented by Mr. William Hope, Washington, D. C., through Mr. W. W. Tracy, sr. Received March 24, 1909. Numbered April 5, 1909.

25198. *Mecadena.*

25199. *Miguel Preto.*

25200. *Picuhy.*

25201. *Puereca.*

25202. *Taresa.*

25203. *Bahiana.*

25204 to 25219.

From Bremen, Germany. Presented by Dr. George Bitter, director, Botanical Garden. Received March 26, 1909.

The following seeds:

25204. Chloris submutica H. B. K.

Distribution.—A native grass of Mexico, extending north as far as San Luis Potosi.

25205. Erodium semenovii Reg. & Herd.

Distribution.—An annual plant, found in the valley of the Volga River and on the borders of the Caspian Sea in southeastern Russia.

25206 and 25207. Festuca elatior L.

25208 and 25209. Festuca elatior arundinacea (Schreb) Celak.

25210 and 25211. Festuca spectabilis Jan.

Distribution.—A native of the mountainous regions of central Europe, extending from the Tyrol into Croatia and Dalmatia.

25212. Glycine hispida (Moench) Maxim. **Soy bean.**

Brown.

25213. Melilotus messanensis (L.) All.

Distribution.—An annual plant, found in the countries bordering on the Mediterranean Sea.

25214. Melilotus suaveolens Ledeb. (?)

25215. Melilotus wolgica Poir.

Distribution.—A native of the southern part of Russia.

25216. Melilotus sp.

25217. Phalaris minor Retz.

Distribution.—A native of the countries bordering on the Mediterranean Sea, and cultivated or introduced in central Europe.

25218. Phaseolus vulgaris L.

25219. Phleum paniculatum Huds.

Distribution.—An annual grass, native of the countries of southern Europe, and extending east to Persia and Afghanistan.

25221. MEDICAGO SATIVA L. **Alfalfa.**

From Rocky Ford, Colo. Grown by Mr. P. K. Blinn in 1907. Received through Mr. J. M. Westgate, fall of 1908.

Guaranda. "Grown from No. 14972. Seventeen ounces of seed was secured from 50 individual plants, 6 months old, grown in cultivated rows 20 inches apart with the plants 20 inches apart in the rows." (*Westgate.*)

25222 and 25223. MEDICAGO SATIVA L. **Alfalfa.**

From Chillicothe, Tex. Grown by Mr. A. B. Conner, season of 1908. Received through Mr. J. M. Westgate, fall of 1908.

25222. "Grown from No. 12549. This alfalfa while not quite so hardy as ordinary western-grown alfalfa produces excellent yields of hay and seed in places where it does not winterkill." (*Westgate.*)

25223. *Guaranda.* "Grown from No. 14972. The heaviest seeding strain of any under test in the alfalfa nursery at Chillicothe." (*Westgate.*)

25224. HIPPEASTRUM VITTATUM (L'Her.) Herbert.

From Washington, D. C. Transferred to the Office of Foreign Seed and Plant Introduction by Mr. E. M. Byrnes, superintendent of Gardens and Grounds, United States Department of Agriculture, April 1, 1909.

"Two-year-old hybrids, the result of crosses made by Mr. Byrnes in the spring of 1907 between a few unnamed varieties of different shades of color and markings. The bulbs are regarded by Mr. Byrnes as exceptionally large sized for their age and those which have bloomed so far as a decided improvement over the parents." (*W. Fischer.*)

25225 to 25242. SACCHARUM OFFICINARUM L. **Sugar cane.**

From Central Soledad, Cienfuegos, Cuba. Presented by Mr. Robert M. Grey, Harvard Botanical Experiment Station. Received at the South Texas Garden, Brownsville, Tex., February 18, 1909. Numbered April 7, 1909.

Descriptive notes on the following by Mr. E. C. Green:

25225. *Barbados* No. 109 ♀ × *Ribbon* ♂.

(Harvard No. 1.) (S. T. G. No. 2005.) Dark cream to brown; average length of joints 3 inches; average length of canes 4 feet 3 inches, diameter 1 inch.

25226. *Barbados* No. 109 ♀ × *Ribbon* ♂.

(Harvard No. 5.) (S. T. G. No. 2006.) Dark cream to brown; average length of joints 3½ inches; average length of canes 3 feet 6 inches, diameter 1¼ inches.

25227. *Barbados* No. 109 ♀ × *Ribbon* ♂.

(Harvard No. 12.) (S. T. G. No. 2007.) Dark cream to brown; average length of joints 3½ inches; average length of canes 4 feet, diameter 1¼ inches.

25228. *Demarara* No. 95 ♀ × *Crystallina.*

(Harvard No. 15.) (S. T. G. No. 2008.) Yellow to dark green; average length of joints 2¾ inches; length of canes 4 feet, diameter 1 inch.

25229. *Demarara* No. 95 ♀ × *Crystallina.*

(Harvard No. 16.) (S. T. G. No. 2009.) Dark red; very stout; average length of joints 4 inches; average length of canes 4 feet 6 inches, diameter 1¼ inches.

25225 to 25242—Continued.

25230. *Crystallina* × *Crystallina.*

(Harvard No. 17.) (S. T. G. No. 2010.) Dark red; very stout; prominent nodes; average length of joints 3½ inches; average length of canes 2 feet 6 inches, diameter 1¼ inches.

25231. *Harvard* No. 208 × *Ribbon.*

(Harvard No. 22.) (S. T. G. No. 2011.) Dark red; stout; joints 3½ inches; canes average 3½ feet in length, diameter 1¼ inches.

25232. *Java* No. 51 × *Java* No. 51.

(Harvard No. 36.) (S. T. G. No. 2012.) Yellow to dark brown tinted with green; joints 3¾ inches long; average length of canes 5 feet 6 inches, diameter 1 inch.

25233. *Java* No. 51 × *Java* No. 51.

(Harvard No. 45.) (S. T. G. No. 2021.) Red with yellow; joints 3½ inches long; prominent nodes; canes 4 feet long, diameter 1 inch.

25234. *Barbados* No. 109 ♀ × *Ribbon* ♂.

(Harvard No. 48.) (S. T. G. No. 2022.) Yellow; very stout; joints 3½ inches long; canes 2 feet long, diameter 1½ inches.

25235. *Caledonia Queen* × *Crystallina.*

(Harvard No. 73.) (S. T. G. No. 2015.) Dark red; exceptionally stout; joints 3½ inches long; length of canes 4 feet 3 inches, diameter 1½ inches.

25236. *Barbados* No. 109 × *Crystallina.*

(Harvard No. 75.) (S. T. G. No. 2016.) Light green with yellow tints; joints 5½ inches long; canes 4 feet long, stocky, diameter ⅜ inch.

25237. *Barbados* No. 109 × *Crystallina.*

(Harvard No. 76.) (S. T. G. No. 2017.) Light green with yellow tints; joints 2½ inches long; canes 2 feet long, stocky, diameter 1⅜ inches.

25238. *Barbados* No. 109 × *Crystallina.*

(Harvard No. 77.) (S. T. G. No. 2018.) Light green with yellow tints; joints 4 inches long; canes 2½ feet long, diameter 1 inch.

25239. *Crystallina* × *Crystallina.*

(Harvard No. 198.) (S. T. G. No. 2019.) Dark red; joints 6 inches long; canes 5 feet long, diameter 1 inch.

25240. *Crystallina* × *Crystallina.*

(Harvard No. 208.) (S. T. G. No. 2020.) Yellow with green stripes; joints 5 inches long; canes average 5 feet 3 inches.

25241. *Java* No. 51 × *Java* No. 51.

(Harvard No. 37.) (S. T. G. No. 2013.) Dark red tinged with yellow; joints 6 inches long and very stout; length of canes 4 feet, diameter 1½ inches.

25242. *Barbados* No. 109 × *Crystallina.*

(Harvard No. 39.) (S. T. G. No. 2014.) Dark red; joints 5 inches long, stout; canes 4 feet long, diameter 1¼ inches.

25243. TRITICUM AESTIVUM L. **Wheat.**

From Seoul, Korea. Presented by Mr. Thomas Sammons, American consul-general. Received April 7, 1909.

"The Korean variety of wheat, although very poor, grows well." (*Sammons.*)

25244. MEDICAGO SATIVA L. **Alfalfa.**

From Alma, Nebr. Grown in the summer of 1908 by Mr. Conrad Boehler. Received through Mr. J. M. Westgate, April 7, 1909.

Grimm. "A field of ordinary alfalfa was in bloom alongside of the field from which this seed was obtained, and some cross-pollination may have taken place." (*Westgate.*)

25245. ANACARDIUM OCCIDENTALE L. **Cashew.**

From Ancon, Canal Zone, Panama. Presented by Mr. H. F. Schultz. Received April 8, 1909.

A yellow-fruited variety. See No. 5205 for description.

Distribution.—A small tree, native of Tropical America, extending from Brazil north to Mexico and the West Indies. Cultivated and naturalized in India and other tropical countries.

25246. EUCALYPTUS TRABUTI Vilmorin.

From Algeria. Presented by Dr. L. Trabut, government botanist, Mustapha-Alger, Algeria. Received April 7, 1909.

"A hybrid of *E. botryoides* × *rostrata*. Tree very vigorous, wood very good, growth rapid, stem straight and high. Comes true to seed." (*Trabut.*)

25247 to 25250. IPOMOEA spp.

From Miami, Fla. Procured from Mr. P. J. Wester, in charge, Subtropical Garden. Received April 8, 1909.

Seed of each of the following. Procured for experiments being made by Prof. H. J. Webber, Cornell University, Ithaca, N. Y.

25247. IPOMOEA SINUATA Ortega.

Distribution.—A native of the sandy shores from Georgia to Texas, and extending south through Central America into Brazil; also in the West Indies.

25248. IPOMOEA JALAPA (L.) Pursh.

Distribution.—A native of America, being found on the sandy shores along the coast from South Carolina to Florida and in Mexico and the West Indies.

25249. IPOMOEA SETOSA Ker.

Distribution.—A native of Brazil, and also found in Jamaica, probably introduced.

25250. IPOMOEA sp.

"Found growing on wet land in the neighborhood." (*Wester.*)

25252. ZEA MAYS L. **Corn.**

From a highland valley near Cuzco, Peru (11,500 feet). Presented by Mrs. Harriet Chalmers Adams, Washington, D. C. February, 1909.

"Red corn of the Quichuas." (*Adams.*)

25253. PELARGONIUM ODORATISSIMUM (L.) Ait. **Rose geranium.**

From Valencia, Spain. Presented by Mr. J. L. Byrne, American vice and deputy consul, at the request of Mr. R. M. Bartleman, American consul, Madrid, Spain. Received April, 1909.

"There is only one variety of the rose geranium cultivated in this region for its perfume. Judging from inquiries occasionally received at this consulate from Ameri-

25253—Continued.

can horticulturists and perfumers, it would appear that an impression prevails in the United States that the rose geranium employed in the famous essence manufactory near this city is a special variety peculiar to the district. Such, however, is not the case, but the plants raised in the vicinity of Valencia have been distinguished from time immemorial by the intensity of their fragrance and the quantity of essential oil they yield, qualities which undoubtedly depend to some extent on local climatic and soil conditions, as the same geranium transplanted to other European countries, and even to other regions of Spain itself, loses considerably in this respect. The plants used in the purfume distillery are grown close to the sea on soil so extremely light and sandy that in some places it looks like a continuation of the seashore." (*Byrne.*)

25254. Stizolobium sp.

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received April, 1909.

"This is widely cultivated in Hokkaido. *The Useful Plants of Japan* has to say: '*Mucuna capitata* Wight et Arn., Jap. *Osharaku-mame, Hassho-mame;* an annual leguminous climber cultivated in common dry land. The young soft grains are eaten boiled and have a taste of *Vicia faba* L., but this bean contains a poisonous ingredient in a slight quantity; so it is advisable to eat moderately.'" (*Yokohama Nursery Company.*)

Note.—The above seed was sent in as *Mucuna capitata;* hence the description.

25255. Phaseolus angularis (Willd.) W. F. Wight.

Grown at Arlington Farm, Virginia, season of 1908. Received in the fall of 1908.

"Grown from Agros. No. 0516. This seed was received from the Tokyo Botanical Garden in 1907. The seed is a pale-straw color or nearly white, much lighter than any other variety yet obtained." (*C. V. Piper.*)

25256. Dolichos lablab L. **Bonavist bean.**

From Paris, France. Purchased from Vilmorin-Andrieux & Co. Received April 10, 1909.

Stringless. Mottled reddish brown.

25257. Medicago sativa L. **Alfalfa.**

From Bargen, Baden, Germany. Secured from Mr. Adam Joos, Bargen, near Sinsheim, Baden, through Mr. Charles J. Brand. Received April 12, 1909.

Pfalzer luzerne. "This seed was grown in the Bavarian Rhine Palatinate. (P. L. H. No. 3438.)" (*Brand.*)

25258. Avena sativa L. **Oat.**

From Sebenico, Dalmatia, Austria. Presented by Mr. Carlo Ruggeri. Received April 7, 1909.

25259 and 25260.

From Palestine. Presented by Mr. E. F. Beaumont, Jerusalem, Palestine. Received April 10, 1909.

25259. Avena sativa L. **Oat.**

From Plain of Sharon, near Jaffa.

25260. Hordeum sp. **Barley.**

From mountain country around Jerusalem.

25261 and 25262. Stizolobium spp.

From Saigon, Cochin China. Presented by the director of the Botanical Garden, through Mr. Jacob E. Conner, American consul. Received April 12, 1909.

25261. **Florida velvet bean.**

25262.

Black seeded.

25263. Stizolobium sp.

From Calcutta, India. Presented by Mr. William H. Michael, consul-general, who procured them from the Reporter of Economic Products to the Government of India. Received April 13, 1909.

"These were collected from wild plants in the neighborhood of Calcutta, but the Mucuna (Stizolobium) can not be said to be cultivated here." (*Michael.*)

25264 to 25266.

From province of Saxony, Germany. Secured from Mr. Ludwig Pfoh, Ober-Inspector des Ritterguts, Zöschen, near Merseburg, Germany, through Mr. Charles J. Brand. Received April 12, 1909.

25264. Medicago sativa L. **Alfalfa.**

Alt-Deutsche Fränkische luzerne.

25265. Medicago sativa varia (Mart) Urb. **Sand lucern.**

25266. Trifolium pratense L. **Red clover.**

This sample of German red clover was grown from seed originally produced in Württemberg.

25267 and 25268. Medicago spp.

From Berlin, Germany. Secured from Metz & Co., Steglitz, near Berlin, Germany, through Mr. Charles J. Brand. Received April 13, 1909.

25267. Medicago sativa L. **Alfalfa.**

Grown in Germany. (P. L. H. No. 3454.)

25268. Medicago sativa varia (Mart) Urb. **Sand lucern.**

Bohemian.

25269 and 25270. Medicago sativa L. **Alfalfa.**

From Bucharest, Roumania. Secured from the Ministry of Agriculture, Industry, Commerce, & Domains of Roumania, through Mr. E. W. Jenkins, Dover, Del. Received April 12, 1909.

"Both of these samples of seed were grown on the model farms conducted by the experiment station for the selection and breeding of cereals of the Roumanian Government." (*C. J. Brand.*)

25269. Was grown on the model farm "Studina," at Frasinet.

25270. Was grown on the model farm "Laza," which is located at Vasluiu.

25274. Litchi chinensis Sonner. **Leitchee.**

From Fuchau, China. Received through Mr. Samuel L. Gracey, American consul, at the Plant Introduction Garden, Chico, Cal., March 30, 1909.

For previous introductions, see No. 23202, etc.

Distribution.—Native and cultivated in the southeastern part of China; also cultivated in India. A few plants of the species are reported as growing in the West Indies.

25276. Trifolium suaveolens Willd.

From Tashkent, Turkestan. Procured by Prof. N. E. Hansen, of the Agricultural Experiment Station, Brookings, S. Dak., in 1908, while traveling as an agricultural explorer for the Department of Agriculture. Received April 12, 1909.

Distribution.—See No. 24548.

25277 to 25279. Medicago sativa L. **Alfalfa.**

From Turkestan. Procured from Mr. H. W. Durrschmidt, Tashkent, Turkestan, by Prof. N. E. Hansen, of the Agricultural Experiment Station, Brookings, S. Dak., in 1908, while traveling as an agricultural explorer for the Department of Agriculture. Received February 23, 1909.

25277. *Aulieata.*

25278. *Khiva.* Polished by machine.

25279. *Vernoe.*

Note.—A previous shipment of alfalfa (No. 23203), received under the name *Vernoe*, or *Tschilik*, is presumably the same variety and from the same location as the above.

"The *Aulieata* is from Aulicata, Semirechensk, north of Tashkent. The *Vernoe* is from Vernoe, Semirechensk, 600 versts northeast of Tashkent." (*Hansen.*)

52280. Pisum arvense L. **Field pea.**

From Nephi, Utah. Presented by Mr. F. D. Farrell, assistant agronomist, Agricultural Experiment Station, Logan, Utah. Received April 19, 1909.

"These were grown in 1908, from seed obtained from Colorado. Variety not known. Best yielding variety in 1908." (*Farrell.*)

25281. Caesalpinia coriaria (Jacq.) Willd. **Divi-divi.**

From Rio Hacha, Colombia. Presented by Sr. José Bolivar Nuñez. Received April 17, 1909.

See No. 23335 for description.

Distribution.—A tree found in the southern part of Mexico, in the vicinity of Tehauntepec, and in Venezuela and the islands of Jamaica, Trinidad, and Haiti.

25309. Amygdalus persica L. **Peach.**

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received April 21, 1909.

"*Tenshin* blood peach."

25315. Zinziber officinale Rosc. **Ginger.**

From Sibpur, Calcutta, India. Presented by Prof. A. T. Gage, superintendent, Royal Botanic Garden, Calcutta. Received April 23, 1909.

Procured for Dr. R. H. True's experiments.

25316. Pinus gerardiana Wall.

From Fort Sandeman, Baluchistan. Procured from Lieut. Col. G. C. Trench, I. A., political agent in Zhob. Received April 22, 1909.

See No. 21819 for description.

25316—Continued.

Distribution.—A large tree, native to the dry interior valleys of the Himalaya Mountains in the northern part of India and Afghanistan, rising to an elevation of 12,000 feet.

25317 and 25318. AVENA SATIVA L. Oat.

From Madrid, Spain. Presented by Mr. R. M. Bartleman, American consul. Received April 22, 1909.

Seed of the following:

25317. "Spanish oats, first quality."

25318. "Spanish oats, second quality."

25319. AVENA SATIVA L. Oat.

From Toscana, Italy. Presented by Mr. Willy Müller, Hortus Nucerensis, Nocera Inferiore, Italy. Received April 16, 1909.

"First quality oats."

25320 to 25323. AVENA SATIVA L. Oat.

From Spain. Presented by Don Emillano Lopez, Murcia, Spain. Received April 15, 1909.

Seeds of each of the following:

25320. *Hungria.*

25321. *Kirsche.*

25322. *Lioscoln.*

25323. *Gigante.*

25324 to 25326. AVENA SATIVA L. Oat.

From Valencia, Spain. Presented by Escuela Pratica de Agricultura, at the request of Hon. Charles S. Winans, American consul. Received April 22, 1909.

25327. MEDICAGO SATIVA L. Alfalfa.

From Hamburg, Germany. Secured from R. Liefman Sons, Successors, through Mr. Charles J. Brand. Received April, 24, 1909.

Alt-Deutsche Fränkische luzerne.

25328 to 25344.

From the district Sansane-Mangu, in the northern part of Togo, German West Africa. Presented by Doctor Meyer, Governor of Togo. Received April 7, 1909.

The following seeds collected December 28, 1908. Quoted notes by the collector; descriptions of varieties by Mr. Carleton R. Ball.

25328 to 25342. ANDROPOGON SORGHUM (L.) Brot.

25328. "Native name *Aparku fofoé.* Grown on the lighter sandy soils of the grass steppe. An early variety, ripening in 4 months; 2 or 3 meters high." Variety *ovulifer* Hack., form I, with black glumes and white seeds. Almost identical with S. P. I. No. 18180.

25329. "Native name *Aparku* (rot). On light sandy soils. An early variety, growing 2 or 3 meters high." Variety *ovulifer* Hack., form II, with black glumes and reddish brown seeds. Equivalent to S. P. I. No. 18198.

25328 to 25344—Continued.

25328 to 25342—Continued.

25330. "Native name *Adyiba* (rot). Lighter sandy soils containing swamp ore; 2 to 3 meters high. A late variety, ripening in 6 months. Used for flour and beer." Variety *ovulifer* Hack., form VI. Glumes dark reddish brown. Equivalent to S. P. I. No. 18189.

25331. "Native name *Adyiba* (weiss). From same soil as preceding (S. P. I. No. 25330), and same description applies to it." Variety *ovulifer* Hack., form I, with black glumes and seeds white with a slight yellowish tinge.

25332. "Native name *Banambo*. Light sandy soils. Differs from preceding in color of seeds. More commonly used for flour making. Ripens in 6 months." Variety *ovulifer* Hack., form I, with black glumes and seeds white with a slight yellowish tinge.

25333. "Native name *Tyentyenyark*. Light clay and sandy soils; 3 meters high. An early variety used for flour. Ripens in 5 months." Same as No. 25330; equivalent to S. P. I. No. 18190.

25334. "Native name *Soch* (Sopienge). Light clay and sandy soils. Grows 2 to 3 meters high. An early variety, ripening in 4 months. Used for flour because of the very white seed coats." Variety *elegans* Kcke. White seeded.

25335. "Native name *Somong*. Soils as in Togo No. 6 (S. P. I. No. 25333). Grows 2 to 3 meters high. Early ripening sort with white seeds like Togo No. 7 (S. P. I. No. 25334)." Variety *elegans* Kcke. A red-seeded form equivalent to S. P. I. No. 18196.

25336. "Native name *Langpategu*. Soils as in No. 6 (S. P. I. No. 25333). Heads shorter and more compact than in the preceding forms; white hulled. An early variety used for making beer and flour. The most prized variety of the Moba people." Represents the variety *intermedius* B. & P. Remarkable for its bluish gray seed; somewhat like a *New Era* cowpea in color.

25337. "Native name *Pebate*. Grows 3 to 4 meters high. A late ripening variety, requiring 6 months to mature." Variety *elegans* Kcke., having shorter, blunter, and more compressed glumes.

25338. "Native name *Tanyou* (lila)." Variety *intermedius* B. & P. Very similar to S. P. I. No. 25336.

25339. "Native name *Nyumbayone bimle* (Doppelfrucht). Originally from Haut Senegal, Guinea. In this variety the black glumes contain always 2 kidney-shaped white seeds." Belongs apparently to variety *elegans* Kcke., but differs from all other forms in having 2 seeds to each spikelet, a condition which occurs in a number of varieties from India.

25340. "Native name *Beninga* (Pferdefutter). With specially hard-hulled seeds. Used for horse feed." Probably variety *bicolor* Kcke. Seeds pure white, equaled in length by the jet-black shining glumes, a form not previously reported from Togoland.

25341. "Native name *Ehpeto* (gelb). Grows 3 to 4 meters high. A late ripening sort, requiring 7 months. The meal has a somewhat bitter taste." Belongs to variety *kerstingianus*, subvariety *sulfureus* B. & P. Remarkable for its sulphur-yellow seed. Equivalent to S. P. I. No. 18147.

25328 to 25344—Continued.

25328 to 25342—Continued.

25342. "Native name *Solemondi.* From light sandy soils; 3 meters high; a late ripening variety. The leaves contain a coloring matter used for cloth and leather; otherwise used only for chicken feed." Variety *colorans* Pilger. Seeds of this variety are used for producing a red color or by the addition of the leaves of certain trees they may be used for producing a black color. Equivalent to S. P. I. No. 18165.

25343 and 25344. Pennisetum americanum (L.) Schum. **Pearl millet.**

25343. "Native name *Nyepé* (weiss). Grown on the lighter sandy soils; 1.5 meters high."

25344. "Native name *Nyepé* (dunkel). Grown on the lighter sandy soils; 1 to 1.5 meters high."

25347. Mucuna atropurpurea (Roxb.) DC.

From Peradeniya, Ceylon. Presented by Dr. John C. Willis, director, Royal Botanic Garden. Received April 23, 1909.

Distribution.—A woody climber, native of the plains of India and Ceylon.

25350. Chalcas paniculatus L.

From Buitenzorg, Java. Presented by Dr. M. Treub, director, Botanic Gardens. Received April 30, 1909.

"The wood is close grained, hard, white, and has been used for wood engraving." (*Brandis, Forest Flora of India.*)

Distribution.—A tree or shrub, native of southeastern Asia, where it rises to an elevation of 4,500 feet in the Himalaya Mountains, and of the Malay Archipelago and Australia. Cultivated in gardens as an ornamental in its native countries and in southern Florida and California; also used as a greenhouse plant.

25351 to 25371.

From Madrid, Spain. Presented by Dr. Luis Atrido y Ramos, director, Botanic Gardens. Received April 13, 1909.

The following seeds:

25351. Avena nuda L.

25352. Avena planiculmis Schrad.

Distribution.—A native of the meadows in the mountainous parts of southern Europe and Asia Minor.

25353 to 25360. Avena sativa L.

25361 to 25363. Avena sterilis L.

Distribution.—A native of the Mediterranean region, found as a weed in cultivated fields.

25364. Avena strigosa Schreb.

Distribution.—A native of Europe and western Asia, cultivated and occurring as a weed in cultivated fields.

25365 to 25367. Avena sp.

25368. Deschampsia alpina (L.) R. & S

Distribution.—A native of northern Europe, being found mostly along streams and on lake shores.

25351 to 25371—Continued.

25369 to 25371. DESCHAMPSIA ATROPURPUREA (Wahlenb.) Scheele.

Distribution.—A native of arctic regions, extending from Alaska to Labrador, and in northern Europe and Siberia.

25389 and 25390. AVENA SATIVA L. **Oat.**

From Seville, Spain. Presented by Mr. R. L. Sprague, American consul, Gibraltar, Spain. Received April 30, 1909.

25435. LECYTHIS USITATA Miers. (?) **Sapucaia nut.**

From Port of Spain, Trinidad, British West Indies. Presented by Dr. E. Andre. Received May 1, 1909.

"This is the species which produces the well-known sapucaia nuts of commerce; it abounds in the island of Caripe and other parts of the province of Para (Brazil)." (*J. Miers, Transactions, Linnæan Society, vol. 30, p. 208.*)

25436. TUMBOA BAINESII Hook. f.

From German Southwest Africa. Presented by Prof. J. Burtt Davy, government agrostologist and botanist, Transvaal Department of Agriculture, Pretoria, Transvaal, South Africa. Received May 1, 1909.

"A peculiar and rare monotypic plant of the deserts of German Southwest Africa. The short stem produces at its swollen apex, besides the cotyledons, in its entire lifetime only a single pair of yard-long ribbonlike leaves between which are borne the conelike inflorescences. The plant represents in its development (like Gnetum, see No. 19093) a transition stage between the lower gymnosperms, like the pines, and the angiosperms, or flowering plants." (*W. Fischer.*)

Distribution.—A native of the stony desert plains in the vicinity of Mossamedes and Cape Negro in Portuguese West Africa, and in Damara-land in German West Africa.

Note.—This plant is the *Welwitschia miriabilis* of the botanical text-books and is as yet not generally known to the general reader under the above Latin name.

25437 to 25440.

From China. Procured from Mr. H. J. Openshaw, Yachow, Szechwan Province, via Chungking, West China. Received March 3, 1909.

The following seeds; Chinese names given by Mr. Openshaw.

25437 and 25438. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

25437. *Huang dou.* Looks like *Acme.*

25438. *Lu dou.* Very similar to *Guelph.*

25439. PISUM ARVENSE L. **Field pea.**

Wan dou.

25440. DOLICHOS LABLAB L. **Bonavist bean.**

Beh pien dou. White.

25464. CUCUMIS MELO L. **Muskmelon.**

From Yokohama, Japan. Purchased from the Yokohama Nursery Company. Received May 5, 1909.

Makuwa-uri.

25464—Continued.

"This is produced much in the village Makuwa, in the province of Mino, whence the name is derived. The male and female flowers are grown separately on the same vine. The fruits ripen in midsummer. They are oval shaped, about 5 inches long, and of a yellow color, with longitudinal stripes. They are eaten 1 or 2 days after having been collected, and are very sweet and delicious. There are several varieties of different colors and forms." (*Yokohama Nursery Company.*)

25465. MELILOTUS INDICA (L.) All. **Melilot.**

From King Island. Presented by Mr. Henry S. Baker, American consul, Hobart, Tasmania. Received April 20, 1909.

This yellow-flowered melilot, which has made for itself such an enviable reputation in the improvement of the soil of King Island, was introduced there supposedly from the mattresses left on the shore by sailors or washed up on the beach from wrecks of vessels along the coast.

Mr. Henry D. Baker, American consul, Hobart, Tasmania, has furnished the following information about its usefulness on King Island:

Melilot has in the last few years transformed the island, which seemed absolutely barren or given up to worthless vegetation, including chiefly bracken fern and ti-tree scrub, Tussock grasses and rushes, into what is now the most profitable grazing and fattening area in Australasia. It has grown even on raw white sand near the seashore, and in the course of 5 or 6 years has transformed the soil into rich, dark-brown, almost black loam, and made it capable of growing good crops of oats, lucern, etc. Land which half a dozen years ago was worth only a little over one dollar an acre now has an assessed valuation, where melilot is thriving, of about 35 dollars an acre.

Not until there had been severe fires over the island did the growth of melilot become luxuriant or have its usefulness recognized. The seed, encased in a hard shell, appears to germinate more quickly when this shell has been cracked open by fire. Farmers, in securing a stand of melilot on new ground, sow the seed in the scrub and bracken ferns late in the fall or winter and then burn off the brush. This burning of the brush adds potash to the soil and covers the seed, and also improves the germination, as stated previously. If a rain follows the fire, the seed usually germinates quickly and an excellent growth is secured.

This melilot is strictly an annual and dies off each year, the practice being to burn the old stems in January and February. This burning clears the soil of rubbish, and the stand of melilot becomes more perfect each season.

Melilot, in the latter part of November, was on the average about 3 feet high. Cut for hay about the middle of December, it makes splendid feed and all stock like it in this form. The estimated average yield of melilot in dry hay is 2½ tons per acre. Melilot-fed horses are of great size and strength, and have great endurance.

Mr. Baker suggests that melilot might possibly be introduced to advantage on the sandy wastes along the Atlantic and Pacific coasts of the United States, where the climatic conditions are not unlike those of King Island, which is intercepted by the fortieth degree of south latitude and normally has a good rainfall.

It would be a mistake to consider melilot better than alfalfa or other useful home fodders, its advantage being in its ability to redeem poor land. On very fertile soil in New South Wales and Victoria it has proved a rather baneful weed.

25466. RUBUS sp. **Raspberry.**

From Bataan Mountains, Philippine Islands. Presented by Mr. William S. Lyon, Gardens of Nagtajan, Manila, Philippine Islands. Received May 7, 1909.

25466—Continued.

"A rather promising and prolific wild red raspberry. It was in fully ripe fruit March 1 and found at 3,700 feet altitude on dry, rocky, sterile ridges. Should prove hardy. A little dry (not offensively so) and quite as showy as the best garden *Cuthbert* I ever recall seeing." (*Lyon.*)

25467. SOLANUM ZUCCAGNIANUM Dunal.

Grown at Miami, Fla., by Mr. P. J. Wester, in charge, Subtropical Garden. Numbered for convenience in recording distribution, May 8, 1909.

An herbaceous plant, growing about 2 feet high, with smooth, ovate, wavy-margined leaves on long petioles. The flowers are white, borne in clusters of 1 to 3 or more, on short, drooping stems. The fruit is round, about ½ inch in diameter, roughened and furrowed, becoming red when ripe.

25468. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

From Madison, Wis. Purchased from the L. L. Olds Seed Company. Received May 8, 1909.

Wisconsin Black. "This variety has proved to be one of the earliest growing in Wisconsin, but gives a relatively poor yield of seed and forage. While the records are somewhat incomplete, it is almost certainly the direct descendent of S. P. I. No. 5039." (*C. V. Piper.*)

25469. ORYZA SATIVA L. **Rice.**

From Canton, China. Presented by Mr. Leo Bergholz, American consul-general, at the request of Mr. Amos P. Wilder, American consul-general, Hongkong, China. Received May 8, 1909.

Szemiu. "This is absolutely the best rice grown within this province." (*Bergholz.*)

25470 to 25504.

From Chile. Received through Mr. José D. Husbands, Limávida, Chile, April 27, 1909.

Seed of each of the following. Quoted notes by Mr. Husbands.

25470. LAPAGERIA ROSEA R. & P.

"*Coigüe.* A comestible fruit and handsome evergreen vine, very like *Copigue;* strange flowers, medicinal; thrives in the shade on damp soil."

Distribution.—An evergreen vine, found climbing over trees and shrubs in the woods about Concepcion and in the valley of the Rio Itata, in Chile.

25471. ACAENA sp.

"*Cadillo.*"

25472. RUMEX ROMASSA Remy.

"A pest plant that will grow dry anywhere; the leaves are eaten like spinach; animals eat the leaves of this class from the south of Puerto Montt. Might serve to start vegetation in some barren place. Medicinal."

Distribution.—An herbaceous plant, found growing around the villages and along the roadsides in the provinces of Chiloé and Valdivia, in Chile.

25473. GREIGIA LANDBECKI (Lechl.) Philippi.

"*Chupones* from Chiloé."

Distribution.—A native of the mountainous coast of Chile, in the province of Valdivia.

25470 to 25504 Continued.

25474. Salix humboldtiana Willd.

"Wild willow; grows in the sand near rivers. Medicinal."

Distribution.—A native of Central and South America, extending from southern Mexico through Colombia to Chile and Brazil.

25475. (Undetermined.)

"Forest trees from near Puerto Montt."

25476. Greigia sphacelata (R. & P.) Regel.

"*Chupones* from Valdivia."

Distribution.—A native of damp, shady places in the vicinity of Concepcion, Chile.

25477. Gunnera chilensis Lam.

"*Pangue*, from Puerto Montt. Comestible by man and beast; ornamental; medicinal; needs very damp or wet soil or water."

Distribution.—A large-leaved herbaceous perennial found in shallow water and swamps in Chile.

25478. Sophora macrocarpa Smith.

"*Mayu.* A treelet with large bunches of beautiful yellow flowers."

Distribution.—A shrub or small tree, with racemes of yellow flowers, native of Chile.

25479. Sophora tetraptera J. Mill.

"*Pelú.* One of the finest flowering forest trees; wood extra valuable; yellow flowers."

Distribution.—A shrub or small tree, native of New Zealand, Lord Howe Island, Juan Fernandez, and Chile. Several varieties are in cultivation.

25480. Physalis sp.

"*Capuchinos.* A wild, comestible hooded tomato; round; yellow; $\frac{5}{8}$ to $\frac{3}{4}$ inch in diameter; a smooth ball. Perennial."

25481. Galega officinalis L.

"Plant like alfalfa. Two plants found growing in a sand island of the river Mata Quita. The habits, growth, and flowers are like alfalfa; stems hollow and when cut plant grows again quickly; seed pods different. Has a large dense leaf growth. Cattle eat this, but not horses. I should like to know what would come of crossing this with alfalfa."

25482. (Undetermined.)

25483 and 25484. Medicago sativa L. **Alfalfa.**

25483. "A wild sort from the cordillera; a single plant found in the midst of the woods. The same as cultivated sorts. Flowers very dark; might be so from the wood shade."

25484. "Same as above (S. P. I. No. 25483); another plant in a distant part."

25485 and 25486. Trifolium hybridum L. **Alsike clover.**

25485. "Crimson wild sort; beautiful."

25486. "White wild sort."

25487. Trifolium pratense L. **Red clover.**

"Pink, large, cone-shaped flowers; wild."

25470 to 25504—Continued.

25488. (Undetermined.) (Asteraceæ.)

"A perennial plant; whitish leaves; pink flowers; might serve as a fodder plant. Cattle and mules eat it; grows dry in pure sand near vast river beds."

25489. Crinodendron patagua Molina.

"*Patagua.* A beautiful, evergreen shade tree; drooping, white, bell-shaped flowers; tree formed like a weeping willow. Needs damp soil, beside running water, swamps, etc. Lumber lasts long dry. Bad for fuel wood."

Distribution.—A medium-sized tree, growing in the low, swampy woods in the vicinity of Puchacay and Itata, and in the province of Maule, in Chile.

25490. Eucryphia cordifolia Cav.

"*Ulmo* is a hardy giant Chilean forest tree, known from Chile to Victoria as *ulmo;* farther south to Valdivia, Chiloé, and in the far south it is called *muermo.* The wood is hard, fine, and extra durable in water; is largely used for piles driven in the sea, in naval construction, furniture, the industries, etc. Its planks and knees are better than live oak for shipbuilding. The bark and scraped wood contain a great quantity of tannin and are largely used for tanning. The wood shavings are used anywhere that tannic acid is required instead of the acid itself. In combination with linge (*Persea lingue*) the *ulmo* has special merits for tanning.

"As a tree *ulmo* is one of the largest and is extremely handsome; its dark, evergreen, lustrous leaves are so whitened underneath as to be very ornamental. When in flower it is gloriously beautiful. The shape of its white flowers is similar to that of the apple or quince, about 2 inches in diameter. The entire tree is actually covered with immense grand bunches of these flowers, forming an ideal fairy tree of snow, whose bloom is deliciously and incomparably fragrant.

"The *ulmo* is not particular as to soil, but, like linge, needs those that are very damp or wet; in fact, they always grow together as comrades, linge enhancing the beauteous bloom of the *ulmo* upon its superbly dark evergreen leaves."

Distribution.—A tall, white-flowered tree, native of the region around San Carlos, in Chile.

25491 and 25492. Embothrium coccineum Forst.

25491. From Puerto Montt.

25492. From Chiloé.

"*Ciruelillu.* A beautiful flowering tree; blossoms red."

Distribution.—A native of the southern part of Chile.

25493. Weinmannia trichosperma Cav.

Teniu.

Distribution.—A small tree, found in the region of San Carlos, in Chile.

25494 to 25503. Cucumis melo L. **Muskmelon.**

"All sweet; thick flesh; good size; grown dry on low lands where corn and watermelons dried up on account of the unusual drought. Melons grown with much less moisture than watermelons and have no diseases like the latter. Every number is a different kind."

25504. Citrullus vulgaris Schrad. **Watermelon.**

25505. Mangifera indica L. **Mango.**

From Miami, Fla. Received from Mr. P. J. Wester, in charge, Subtropical Garden, May 24, 1909.

Gopalbhog. "The plant from which this inarch was taken was sent to the garden in 1906 by Mr. E. N. Reasoner, of the Royal Palm Nurseries, Oneco, Fla., who imported it from India in 1904." (*Wester.*)

25506. Citrus decumana (L.) Murr. **Pomelo.**

From Amoy, China. Presented by Mr. Julean H. Arnold, American consul. Received at the Plant Introduction Garden, Chico, Cal. April 10, 1909.

Amoy. See No. 21870 for previous introduction and note.

25507. Manihot dichotoma Ule.

From Bahia, Brazil. Presented by Mr. Stevenson, agent of the Royal Mail Company. Received May 25, 1909.

Maniçoba de Jequié.

"The *Maniçoba de Jequié* differs from the *Manihot glaziovii* (Muell.) Arg. in having 3 to 5 lobed leaves, and longer seeds. The tree composes about half of the forest on many of the slopes of the mountains in its native region, and furnishes four to five hundred tons of rubber each year. The plant has only been known since 1901, and the cultivated plantations are just ready to be tapped for the first time." (*Ule, Tropenpflanzer, vol. 11, p. 863.*)

Distribution.—A tree, native of the mountainous region between the Rio Paraguassu and the Rio de Contas, in the eastern part of the province of Bahia, in Brazil.

25508. Schoenocaulon officinale (Schlecht.) Gray. **Sebadilla.**

From New York, N. Y. Presented by Lanman & Kemp, at the request of Dr. L. O. Howard, entomologist. Received May 20, 1909.

See No. 24195 for description.

Distribution.—A native of southern Mexico, in the vicinity of Zimapan, Orizaba, and Vera Cruz, and also of Guatemala and Venezuela.

25509. Citrus decumana (L.) Murr. **Pomelo.**

From Daunt, Cal. Presented by Mr. A. W. Patton, at the request of Mr. Carl Purdy, Ukiah, Cal. Received May 27, 1909.

"This fruit is undoubtedly fine, but the tree has little or no history. It was put out by Mr. A. M. Coburn 10 or 12 years ago. He got the trees from Los Angeles. The only reason we can give for the fruit being extra good is the climatic conditions which prevail here in the foothills of the Sierra Nevada Mountains." (*Patton.*)

25510. Astragalus sp.

From Mongolia. Presented by Mr. W. W. Rockhill, American minister, Peking, China, who procured it from Monseigneur Bermyn, Bishop of West Mongolia. Received May 5, 1909.

White flowered.

25511. Euphorbia antisiphylitica Zucc. **Candelillo.**

From Saltillo, Mexico. Presented by Mr. J. R. Silliman. Received May 12, 1909.

25511—Continued.

"A wild euphorbiaceous Mexican plant which is of great interest because the dry stems yield, it is claimed, from 3 to 5 per cent of a fine hard wax which seems suited to coating phonograph cylinders and similar uses. Grows in the dry semidesert regions of north-central Mexico, Lower California, and southwest Texas." (*Frederic Chisolm.*)

Distribution.—A native of the sandy and stony slopes in the Rio Grande Valley, in Texas and Mexico.

25512. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

From New Orleans, La. Purchased from the J. Steckler Seed Company. Received April 29, 1909.

Steckler's Improved Louisiana Wild. "This variety, which is really a mixture of varieties, is naturalized in parts of Louisiana, where it volunteers from year to year. It has been grown at Arlington Farm, Virginia, for the past 3 years, and proves to be a tall, upright, quite leafy, late variety. Too late for this latitude, but would probably be a valuable variety for Florida, where lateness is desired." (*C. V. Piper.*)

25513. GERBERA JAMESONI Bolus. **Barberton daisy.**

From Cape Town, South Africa. Presented by Mr. H. J. Chalwin, superintendent, Public Gardens. Received May 1, 1909.

"This has a beautiful flower, orange-red in color." (*Chalwin.*)

Distribution.—A native of the Transvaal region of South Africa, especially in the vicinity of Barberton.

25514. MUCUNA GIGANTEA (Willd.) DC.

From Richmond River, New South Wales, Australia. Presented to Mr. J. H. Maiden, director and government botanist, Botanic Gardens, Sydney. Received May 12, 1909.

"This is a tall tree-climbing tropical plant, extending over East India and the Malayan and South Pacific Islands. In New South Wales it only occurs in the northern districts." (*Maiden.*)

25515. CYPHOMANDRA BETACEA (Cav.) Sendt. **Tree tomato.**

From Kingston, Jamaica. Presented by Mr. W. Harris, superintendent, Hope Botanic Gardens. Received May 13, 1909.

See No. 12758 for description.

Distribution.—Native and cultivated in Central and South America, extending south to the vicinity of Buenos Aires. Also cultivated in the West Indies, in the Mediterranean region, and other countries.

25516 and 25517.

From Gobindapur, India. Presented by Mr. A. C. Roy, secretary, Comilla Victoria College. Received April 19, 1909.

Seed of each of the following:

25516. PHASEOLUS RADIATUS L.

Black.

25517. LATHYRUS SATIVUS L.

25518 and 25519. Avena sativa L. **Oat.**

From Maritime Alps, i. e., near Tenda, Italy. Presented by Mr. Alwin Berger, La Mortola, Ventimiglia, Italy. Received May 6, 1909.

Seed of each of the following:

25518. (Marked No. 1.)

25519. (Marked No. 2.)

25520 and 25521. Olea verrucosa (R. & S.) Link. **Wild olive.**

From Wellington, Cape of Good Hope, South Africa. Presented by Mr. Charles P. Lounsbury, government entomologist, Cape of Good Hope, Department of Agriculture, Cape Town, South Africa. Received May 18, 1909.

25520. Cuttings.

25521. Seeds.

See Nos. 9124 and 9559 for previous introductions.

Distribution.—A tree, native of the southern part of Africa, extending from the Cape of Good Hope to the Transvaal region.

25522. Lolium multiflorum Lam. **Rye-grass.**

From Westerlee, Groningen, Holland. Presented by Hommo Ten Have. Received May 19, 1909.

Western Wolths. "This new grass was produced by selection from ordinary rye-grass in the county of Westerwolde, Holland, near the German frontier. In appearance the seed can not be distinguished from Italian rye-grass, but *Western Wolths* grass is strictly an annual plant and far surpasses Italian rye-grass in the rapidity of its growth and the weight of herbage. On good soils, when top-dressed with nitrate of soda, it may be cut 5 or 6 times during the summer. It will thrive on almost all soils, but best results are obtained on heavy loam, clay, or land of a somewhat damp character." (*Extract from circular issued by Hommo Ten Have, wholesale seed merchant, Westerlee, Groningen, Holland.*)

25523. Phaseolus calcaratus Roxb.

Grown at Arlington Farm, Virginia, season of 1908, under temporary No. 0513. Received fall of 1908.

"A small red-seeded variety, obtained from the Tokyo Botanic Garden, Tokyo, Japan, in 1906." (*C. V. Piper.*)

25524 and 25525. Cynara scolymus L. **Artichoke.**

From Paris, France. Purchased from Vilmorin-Andrieux & Co. Received May 12 and 13, 1909.

Seeds of the following:

25524. *Green Provence.* **25525.** *Perpetual.*

25527. Buchanania latifolia Roxb.

From Kavali, Nellore District, India. Presented by Rev. E. Bullard. Received May 17, 1909.

"This is called in the Lelugu language *sara* tree. The fruit is gathered and the pulp being removed the seed is cracked and the inside kernels are eaten as we eat nuts. It is very rich and is considered to be very nice and is eaten roasted a little and, if desired, with honey or salt; it is very wholesome, but should be eaten in small

25527—Continued.

quantities only at a time, say not more than a handful of the fruit at a time. The outside part of the fruit is also eaten. The inner part of the seed is sold at the rate of about 20 cents a quart measure full. The tree grows about as high as a small orange tree." (*Bullard.*)

"A large tree belonging to the Anacardiaceae, to which the pistache nut and cashew nut also belong. Its characteristic bark makes this tree conspicuous wherever it is found. On dry hills like the Siwalik Range it is very useful in covering the ground, and it is equally at home on newly formed landslips as on gentle slopes with fairly good soil. The wood is of poor quality. Brandis says the bark is used for tanning. It gives a gum copiously in large irregular pieces; this gum is only partially soluble in water (about 10 per cent insoluble), but what is soluble gives a good mucilage, and it has been reported as likely to be useful for cheap manufacturing purposes and valued at 20s. per cwt." (*Extract from Gamble's Manual of Indian Timbers.*)

Distribution.—Found in the hot, dry parts of India, from Kumaon and Oudh, through central India, and into Burma and Tenasserim, in the eastern peninsula.

25528 to 25530.

From Paraguay, South America. Presented by Mr. Thomas Ruffin Gwynn, Capilla Horqueta, Departamento de V. Concepcion. Received May 19, 1909.

The following seeds:

25528. ROLLINIA EMARGINATA Schlecht. (?)

"*Chirimoyia* (araticuý). It is a large fruit, aromatic to the utmost; seed full of oil." (*Gwynn.*)

Distribution.—A native of southern Brazil and the northern parts of Argentina and Paraguay.

25529. ILEX PARAGUARIENSIS St. Hil.

"*Yerba* (caá). The tea of this country. To procure plants from this seed it will be necessary to put it in hot water of about 90° F. for 26 hours, then plant in a hotbed, the seed being buried about ½ inch under a soft mold, constantly watered every day. When large enough to harvest, you cut all the limbs and twigs, scorch well, and dry twigs and leaves over a hot fire, after which twigs and leaves are ground fine and used as tea, being put in a small gourd with hot water poured on, and a tube perforated at the bottom to suck up the same." (*Gwynn.*)

Distribution.—A native of Paraguay and cultivated in Argentina and Brazil.

25530. BOMBAX sp.

"Vegetable silk (paina), used here for pillows and mattresses, though some fine hammocks and shawls have been woven out of it. This plant opens its pod in July and August here, representing October and November with us." (*Gwynn.*)

25532. GLADIOLUS sp.

From Pretoria, Transvaal, South Africa. Presented by Mr. F. T. Nicholson, secretary, Transvaal Agricultural Union. Received May 21, 1909.

25533 and 25534.

From Ancon, Canal Zone, Panama. Presented by Mr. H. F. Schultz. Received May 27, 1909.

25533 and 25534—Continued.

The following seeds:

25533. PRITCHARDIA PACIFICA Seem. & Wendl.

A spineless fan palm, remarkable for its fibrous, fluffy leafstalks.

Distribution.—A native of the Fiji and the Samoa Islands.

25534. CARLUDOVICA sp.

25535 and 25536. BELOU MARMELOS (L.) W. F. Wight. **Bael.**

From India. Presented by Mr. A. Howard, Imperial Department of Agriculture, Pusa, Bengal. Received April 30, 1909.

Seed of each of the following:

25535. A variety from Madhaipore, near Dalsing Serai.

25536. A small variety from Dalsing Serai, Tirhoot, which is considered to have a good flavor.

See Nos. 22957 and 24450 for general descriptive notes.

Distribution.—A small tree, native of India, being found on dry hills from Jhelum to Assam and south to Travancor.

25537. MEDICAGO SATIVA L. **Alfalfa.**

From Mitchell, S. Dak. Presented by Prof. W. A. Wheeler. Received May 29, 1909.

Baltic. "Grown from S. D. No. 167. This strain, which was originally secured near Baltic, S. Dak., has proved extremely hardy and drought resistant; it possesses the same variegated flowers that are to be observed in the *Grimm* alfalfa and the commercial sand lucern." (*J. M. Westgate.*)

25538 to 25540. CUCUMIS MELO L. **Muskmelon.**

From Spain. Presented by J. Lapoulide & Co., Madrid, at the request of Hon. Maddin Summers, American vice-consul. Received May 20, 1909.

"Three varieties, as follows: From Añover, large and sweet. From Valencia, early and very productive. From Villaconejo, valuable for its keeping qualities." (*Lapoulide & Co.*)

"I frankly believe that the introduction of these muskmelons in the United States is a most important matter. The fact is I know of no plant that can equal this one in intrinsic value to the farmer. To say that a successful cultivation of it may mean millions is very little. It means hundreds of millions in time and will be a boon to our farmers entirely unexpected.

"It has been a mania of mine for years, but I have had difficulty in getting some one interested in the matter. In my humble opinion if we can introduce this product, my work as consul here will be well crowned, as the results will be incalculable.

"I do not know if you exactly appreciate the magnificence of this fruit. Our cantaloupes and other classes of melons are common as compared with a first-class Spanish 'melon.' During the month of January and February I had a large lot hanging in my cellars suspended by hemp coverings. Several very prominent New York club men, who were very particular about their menus and criticised the Hotel de la Paix and the Hotel de Paris for their food, dined with us. It appears that their great complaint came from the fact that in Spain, a country famous for its fruits, they could find nothing that warranted this 'fama.'

25538 to 25540—Continued.

"I then put several melons on ice—imagine in February—and they were served. At first they hesitated, and could not believe that a green looking melon, at that time of the year, could be eaten. They tried it, and asked that others be put on ice, as they had never tasted so delicious a fruit in their lives. They took with them a large quantity and asked me the address of a dealer to have a lot sent to them in New York. The next day they wrote me a letter and asked if they could come to tea and if I would have some more of these melons on ice.

"This fact will show you really what they are. These melons can easily be kept until March by paying great attention to the dryness of the cellars where they are kept. The yield per acre is very large and the great question is to obtain pure seeds. There are, however, planters who pay great attention to the matter and grow on their estates only the pure melon. In Guadalajara there are some and in Valencia there are the best.

"They are never hung in the sun to ripen. They are picked just before ripening, covered with a jute net, and hung up in a dark, dry place. When they are to be eaten they are taken out, hung in the sun for a short time, and when soft at the ends are ready for use." (*Extract from letter of Hon. Maddin Summers, April 20, 1909.*)

25541 and 25542.

From Sibpur, Calcutta, India. Presented by Prof. A. T. Gage, superintendent, Royal Botanic Garden. Received June 2, 1909.

Seed of each of the following:

25541. TERMINALIA BELLERICA (Gaertn.) Roxb.

"A handsome tree, native in southern Asia, the fruits of which, collected when full grown but still unripe, and dried in the sun, form the Beleric myrobalans of commerce. These fruits contain about 12 per cent of tannin, but as a tanning material are inferior to the fruits of the following species." (*W. W. Stockberger.*)

Distribution.—A large tree, found throughout India, and in Ceylon and the Malay Archipelago.

25542. TERMINALIA CHEBULA Retz.

"A large deciduous tree, occurring chiefly on the mountains of India. The fruits, known as Chebulic myrobalans, are extensively used in tanning, over 20,000,000 pounds being imported into the United States in 1908 for that purpose. These fruits yield from 30 to 40 per cent tannin, which occurs chiefly in the pulp surrounding the kernel. The tree is occasionally cultivated up to 5,000 feet in the Himalayas. Seedlings grown at Chattanooga, Tenn., were cut down by frost." (*W. W. Stockberger.*)

Distribution.—A tall tree, native of India, extending from Kumaon to Bengal, and in Ceylon and the Malay Archipelago.

25543. ACACIA CATECHU (L.) Willd.

From Saharanpur, United Provinces, India. Presented by Prof. A. T. Gage, superintendent, Royal Botanic Garden, Sibpur, Calcutta. Received June 2, 1909.

"A leguminous tree, native of India and East Africa, naturalized in Jamaica, where it is common in dry locations. It is said to bear some frost and may prove hardy in favorable localities in the southern United States. The extract from the

25543—Continued.

bark and wood forms the drug catechu, and the dyeing and tanning agent cutch." (*W. W. Stockberger.*)

Distribution.—A medium-sized tree, native of India, being found in the Himalayas from the Punjab to Sikkim, and in Burma.

25544 to 25546.

From Alger-Mustapha, Algiers, North Africa. Purchased from Rossier Frères et Soeur. Received May 29, 1909.

Plants of each of the following:

25544. CITRUS BERGAMIA Risso.

"This is the bergamot, grown commercially in some parts of southern Italy for the essential oil which is expressed from the peel of the fruit. This has been imported for the citrus-breeding experiments of the Office of Crop Physiology and Breeding Investigations." (*W. T. Swingle.*)

25545. CITRUS NOBILIS Lour.

Clémentine. See No. 25196 for description.

25546. CLAUCENA LANSIUM (Lour.) Skeels. (Cookia punctata Sonnerat.; Quinaria lansium Lour.; Claucena wampi Oliver.)

"This is the well-known wampee which is cultivated for its fruits in southern China. These fruits are said to be of a very agreeable though somewhat aromatic flavor and are about the size of a loquat, though the tree is probably not so hardy. These plants were imported for the breeding experiments of the Office of Crop Physiology and Breeding Investigations." (*W. T. Swingle.*)

25547. Raphionacme utilis Brown & Stapf. **Ecanda rubber.**

From Ochileso, Africa. Presented by Mr. T. W. Woodside, A. B. C. F. M., Benguella, Angola (via Lisbon). Received June 1, 1909.

"A rubber-producing member of the milkweed family, recently described as a new species. (Kew Bulletin, 1908, p. 215.) The genus already includes about 20 species distributed through the subtropical desert regions of the southern part of Africa. The plant may be described as a perennial herb or very low shrub. There is a large, fleshy, flattened, turnip-shaped, perennial root, said to attain a diameter of 5 or 6 inches, though the present supply does not contain roots larger than 4 inches. The other parts of the plant are annual, except for a short stem or crown which produces a succession of short branches, but apparently only one at a time. Temporary roots appear to be sent out from any part of the permanent root.

"The structure and habits of growth indicate that the plant behaves in nature as an extreme desert type able to survive with very little water and requiring several years to reach maturity. More favorable conditions might hasten development, but might also have an adverse effect on the amount of rubber produced. The proportion of rubber extracted from the fresh roots falls below 1 per cent, too little to justify any assurance of commercial value. But if simple methods of propagation can be learned we may expect to secure strains that contain larger amounts of rubber, through selection and breeding. It is first necessary to ascertain whether the plant can be grown and multiplied in the United States, either from seeds or from cuttings.

"The roots should not be buried too deeply, only enough to bring the stem end to the surface of the ground. Soil of a loose, open texture may be preferable, though we have no detailed information regarding the natural conditions." (*O. F. Cook.*)

25547—Continued.

"I am told that the keeping qualities of the bulb rubber are not good. I do not think that the Portuguese are very competent to decide that matter. The plant bears a pod full of seeds, so that if it proves of value seeds could be had in quantity." (*Woodside.*)

Distribution.—An herbaceous perennial, found in the vicinity of Lake Nyassa, in Central Africa.

25561. MEDICAGO SATIVA L. **Alfalfa.**

Received through Prof. N. E. Hansen, of the Agricultural Experiment Station, Brookings, S. Dak., while traveling as an agricultural explorer for the Department of Agriculture in 1908. Numbered for convenience in keeping records, June 9, 1909.

"(No. 248.) Plants of native alfalfa as grown by the Arabs in the oases of the Desert of Sahara. These I received at Biskra, Algiers, January, 1909." (*Hansen.*)

25580 to 25591. AVENA SATIVA L. **Oat.**

From Bucharest, Roumania. Presented by Hon. Horace G. Knowles, envoy extraordinary and minister plenipotentiary, American Legation. Received May 22, 1909.

The following seeds:

25580. *Duppau.*
25581. *Anderbeck.*
25582. *Mezdeag.*
25583. *Bucium.*
25584. *Besseller No. 2.*
25585. *Ligovo.*
25586. *Probstei.*
25587. *Besseller No. 1.*
25588. *Leutewitz.*
25589. *Comun.*
25590. *Besseller No. 3.*
25591. *Romănesi selection.*

25592 and 25593.

From Sianfu, Shensi, China. Presented by Mr. D. C. Sowers, of the Carnegie Institute, Washington, D. C. Received March 31, 1909.

Seed of the following:

25592. BRASSICA RAPA L. **Turnip.**

Large flat green.

25593. RAPHANUS SATIVUS L. **Radish.**

Red.

25594 and 25595. CUCURBITA PEPO L. **Squash.**

From Japan. Presented by Mr. J. R. Lawrence, Raynham, Mass. Received June 5, 1909.

The following seeds:

25594. *Chirimen.*
25595. *Rikusa.*

25596 to 25604. ORYZA SATIVA L. **Rice.**

From Port of Spain, Trinidad. Purchased from Mr. F. Evans, acting superintendent, botanical department, Department of Agriculture. Received June 8, 1909.

25596 to 25604—Continued.

The following varieties:

25596. *Mutmuria.*

25597. *Mutmuria.* "Possibly different variety from the above (S. P. I. No. 25596)."

25598. *Mutmuria.* "Second variety, large grain."

25599. *Mutmuria.* "Third variety, small grain."

25600. *Jovira.*

25601. *Jarahur.*

25602. *Jarahan.*

25603. *Sahandeya.*

25604. *Joyia.*

25605 to 25607. MEDICAGO SATIVA L. **Alfalfa.**

From Mitchell, S. Dak. Presented by Prof. W. A. Wheeler. Received June 7, 1909.

Seed of the following; descriptive notes by Mr. J. M. Westgate.

25605. *Grimm.* Grown from S. D. No. 162. This special lot proved the hardiest of the 2 lots of *Grimm* alfalfa under test.

25606. *Turkestan.* Grown from S. D. No. 164. In all the tests made at Brookings and Highmore, S. Dak., this has appeared to be almost if not quite perfectly hardy. The best of all the Turkestan alfalfas tested under South Dakota conditions.

25607. *Turkestan.* Grown under S. D. No. 240, originally from S. P. I. No. 991. Hardy but not a prolific seeder.

25608. NAGEIA ELATA (R. Br.) Muell.

From Sydney, New South Wales, Australia. Presented by Prof. J. H. Maiden, director, Botanic Gardens. Received June 7, 1909.

Distribution.—A large tree, native of southeastern Australia, occurring in Queensland and New South Wales.

25609. CAESALPINIA SAPPAN L.

From Sibpur, Calcutta, India. Presented by Prof. A. T. Gage, superintendent, Royal Botanic Garden. Received June 8, 1909.

"A shrubby leguminous tree bearing showy yellow flowers. Adapted to poor dry lands. 'From its quasi-deciduous character would doubtless endure pretty low temperatures' (*W. S. Lyon*). May prove hardy in the Southern States. The wood, known to commerce as sappan wood, yields a red dye; the bark is used for tanning in India and China. As an ornamental it makes a fine hedge." (*W. W. Stockberger.*)

Distribution.—A native of India and the Malay Archipelago.

25610. IPOMOEA sp.

From Belize, British Honduras. Presented by Mr. E. J. F. Campbell, superintendent, Botanical Station. Received June 9, 1909.

"Tubers of an indigenous plant. The tubers are eaten by the natives raw and saladlike. It is known by the name of *ecama.*"

25611 to 25618.

From Chile. Received through Mr. José D. Husbands, Limávida, Chile, June 8, 1909.

The following seeds; quoted descriptions by Mr. Husbands.

25611. GEVUINA AVELLANA Mol.

"From the cordilleras of central Chile. Will not grow north of latitude 34°."

Distribution.—An evergreen tree, native of the Andes of Chile; cultivated sparingly in California.

25612. JUBAEA CHILENSIS (Mol.) Baill.

"Palm of Chile, large tree with very large bunches of nuts."

Distribution.—The native palm of Chile, found in the provinces of Quillota and Maule.

25613. PHRAGMITES VULGARIS (Lam.) B. S. P.

"A tall, wide-leaved, reedlike wild grass, used for thatching houses. Eaten by horned cattle. Ornamental."

25614 to 25617. PERSEA GRATISSIMA Gaertn. f. **Avocado.**

"Paltos, Chile classes, of excellent quality, somewhat smaller than those of Peru."

25618. CUCUMIS MELO DUDAIM (L.) Naudin.

"Fragrant melon; color yellow with red stripes; eatable; is about the size of an orange; plant like other melons but smaller. Crossed with other melons might give something new."

Distribution.—Found in Persia, Egypt, and Algeria, and cultivated in other countries.

25619 and 25620. CITRUS spp.

From Brisbane, Queensland, Australia. Presented by Mr. Ernest G. E. Scriven, undersecretary, Department of Agriculture and Stock. Received June 10, 1909.

25619. CITRUS AUSTRALIS (Cunn.) Planch.

Distribution.—A small tree, native of the southeastern part of Queensland, Australia.

25620. CITRUS AUSTRALASICA Muell.

See S. P. I. No. 21306 for previous introduction and description.

Distribution.—A shrub, native of the southeastern part of Queensland and the northeastern part of New South Wales, in Australia.

25621. AVENA SATIVA L. **Oat.**

From Amasia, Turkey in Asia. Presented by H. Caramanian & Co. Received June 11, 1909.

Soulou Ora.

25622 to 25630.

The following material received at the Upper Mississippi Valley Plant Introduction Garden, Ames, Iowa. Numbered for convenience in recording distribution, June 11, 1909.

25622 to 25630—Continued.

25622. Pyrus sp. **Pear.**

"(Iowa Expt. Sta. No. 464, 1906.) Seeds were secured from Mr. W. S. Ament, Peking, China. In his letter Mr. Ament states that the fruit came from a long distance, mostly from the mountain regions." (*S. A. Beach.*)

25623. Pyrus sp. **Pear.**

"(Iowa Expt. Sta. No. 89, 1907.) Seed received from Mr. H. P. Perkins, Poatingfu, China. In his letter of January 14, 1907, Mr. Perkins says: 'I inclose seeds of the only pear that grows in this region. It is far from being an A–1 pear but it is large and keeps well into the spring.'" (*S. A. Beach.*)

25624. Sorbus sp. **Mountain ash.**

"(Iowa Expt. Sta. No. 407, 1909.) Native to Alaska. Scions received from Prof. C. C. Georgeson, of the Alaska Agricultural Experiment Station, Sitka, Alaska." (*S. A. Beach.*)

25625. Cydonia sp. **Quince.**

"(Iowa Expt. Sta. No. 518, 1906.) Seed received from Mr. Paul D. Bergen, Shantung, China." (*S. A. Beach.*)

25626. Malus sp. **Apple.**

"(Iowa Expt. Sta. No. 519, 1906.) Seed received from Mr. Paul D. Bergen, Shantung, China." (*S. A. Beach.*)

25627. Malus sp. **Apple.**

"(Iowa Expt. Sta. No. 461, 1906.) Seed received from Mr. W. S. Ament, Peking, China. In his letter Mr. Ament states that the fruit came from a long distance, mostly from the mountain regions." (*S. A. Beach.*)

25628. Malus sp. **Apple.**

"(Iowa Expt. Sta. No. 432, 1906.) Seed received from Mr. H. P. Perkins, Poatingfu, China." (*S. A. Beach.*)

25629. Malus sylvestris Mill. **Apple.**

Evaline. "This variety originated in Wisconsin, not in northern Iowa, as erroneously stated by Hansen.[a] It was one of a lot of seedlings grown from seed brought to Fremont, Waupaca County, Wis., largely from Canada. It was introduced by Mr. William A. Springer, of that place. In 1877 Mr. Springer stated that 'it originated many years ago,'[b] and gave the following description of it: 'Original tree on high, level, dark loam soil. Tree quite upright, but spreading with age. Fruit quite large, with yellowish green color; quality excellent. Season, February to March.'

"It is distinct from the *Evelyn*, which originated with Mr. A. B. Lyman, Excelsior, Minn., from seed of the *Wealthy*, and which is a dark-red apple or yellow, striped with red. It is also distinct from a red apple which is being disseminated by Mr. A. D. Barnes, Waupaca, Wis., under the name of *Evelyn.*

"There is a tree of *Evaline* standing in an orchard which was planted on the grounds of the Iowa Agricultural College about 1877. Haas stock was planted and top-worked about 1878 with scions of the *Evaline.* This tree is hardy, healthy, and productive. The fruit is above medium to rather large, greenish or yellowish, often with a faint blush, with a good degree of uniformity in size and appearance; flavor subacid; texture and quality superior to that of

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[a] "A Study of Northwestern Apples," Bulletin 76, South Dakota Agricultural Experiment Station, 1902, p. 49.

[b] Iowa Horticultural Society, Report, 1877, pp. 81–83.

25622 to 25630—Continued.

Northwestern Greening. It bears some resemblance to apples of the *Fall Pippin* type. As grown at Ames it keeps in ordinary storage till midwinter or later.

"Mr. W. T. Macoun, horticulturist of the Central Experimental Farm, Ottawa, Canada, to whom samples of the fruit were submitted, wrote November 13, 1908: 'I have tested and described the *Evaline* apple. I consider it to be better than *Northwestern Greening* in quality. As you say, it approaches very close to the *Fall Pippin*.' Col. G. B. Brackett, United States pomologist, from specimens which were sent him, describes the flesh as yellowish, medium fine, breaking, juicy, subacid, pleasant flavored, good to very good in quality.

"On account of the uniformity of the fruit in size, appearance, and quality, and because of the hardiness of the variety in tree and fruit-bud, it appears worthy of more extended trial in central and northern Iowa as an early winter or midwinter apple for the home orchard. On the college grounds the variety has made a record for hardiness and fruit-bud, having yielded pretty good crops during the seasons of 1907 and 1908 when many other varieties in the station orchards yielded little or no fruit because their blossom-buds or blossoms were killed by the late freezes." (*S. A. Beach in the Report of the Iowa Horticultural Society, 1909.*)

25630. MALUS DIVERSIFOLIA (Bong.) Roem. **Crab apple.**

"(Iowa Expt. Sta. No. 406, 1909.) Crab apple, native to Alaska. Received from Prof. C. C. Georgeson, of the Alaska Experiment Station, Sitka, Alaska. In his letter of April 13, 1909, Professor Georgeson remarks: 'So far as I know there are no wild crab apples in the interior, the species *Pyrus rivularis* (*Malus diversifolia*) is confined in Alaska entirely to the coast region of southeastern Alaska.'" (*S. A. Beach.*)

25631. SEMELE ANDROGYNA (L.) Kunth.

From Funchal, Madeira. Presented by Mr. Alaricus Delmard, Monte Palace Hotel. Received June 12 and 14, 1909.

Franceschi (Santa Barbara) says that it looks like a gigantic smilax and has dark-green tropical foliage which is likely to be mistaken for some of the Indian climbing palms.

Distribution.—An evergreen, climbing vine, native of the Canary Islands, and cultivated as a greenhouse ornamental.

25632 to 25637.

From Eritrea, Africa. Presented by Prof. T. Batorate, director, Colonial Agricultural Experiment Station, Asmara. Received June 1, 1909.

The following seeds:

25632. BARBEYA OLEOIDES Schweinf.

Distribution.—A small tree, native of the middle and higher mountainous regions of the northern part of Abyssinia, and the province of Yemen, in Arabia.

25633. CARISSA EDULIS Vahl.

Distribution.—A tall shrub, found throughout tropical Africa, from Guinea and Nubia, south to Damara-land and the valley of the Zambezi; also in tropical Arabia.

25634. DIOSPYROS SENEGALENSIS Perrott.

25632 to 25637—Continued.

Distribution.—A shrub or tree, from 6 to 40 feet high, native of Guinea and Abyssinia and south to Mozambique, in Africa, and of Yemen, in Arabia. The wood, which is much used by the natives, is white and compact, or black in the center, like ebony.

25635. MILLETTIA FERRUGINEA (Hochst.) Baker.

Distribution.—A large tree, found in Abyssinia. The powdered seeds are thrown into the water to stupify fish, and the tree also furnishes a poison for arrowheads.

25636 and 25637. HYPHAENE THEBAICA (L.) Mart.

25636. From Assab. **25637.** From Argodat.

Distribution.—A palm, native of the valley of the Gambia River in upper Guinea, and of Nubia, Abyssinia, Somaliland, and British East Africa in the Nile Valley; also native of extratropical Egypt and Arabia.

25639 and 25640.

From Perth, western Australia. Presented by Mr. P. L. Richardson, acting inspector-general of forests, Department of Woods and Forests. Received June 3, 1909.

Seed of the following:

25639. XANTHORRHOEA PREISSII Endl.

"This grass-tree, which forms a conspicuous feature of the Australian landscape, is among those strange members of the rush family that have a decided trunk, or caudex. This species often has a trunk attaining a height of 15 feet, surmounted by a dense, symmetrical crown of foliage, composed of a multitude of brittle, linear leaves which spread or curve gracefully in all directions. From the center of this tuft of leaves arises a solitary, scepter-like flower stalk, terminating in a dense cylindrical spike of numerous, closely packed greenish flowers. This picturesque desert plant is well worth trial in the warmer and more arid regions of the United States." (*Extract from Bailey's Cyclopedia of American Horticulture.*)

Distribution.—A native of western Australia, found from St. Stirling Range to the Vasse and Swan rivers.

25640. NUYTSIA FLORIBUNDA (Labill.) R. Br.

A terrestrial tree belonging to the mistletoe family, often 35 feet in height, with spreading branches. The leaves are linear and thick, about 3 inches long, or reduced to small scales on the new shoots. The flowers are orange-yellow, in showy racemes, crowded at the ends of the branches. The fruit is a nut ½ inch long with 3 broad thick wings.

Distribution.—It is a native of western Australia, extending from King George's Sound to the Swan and Murchison rivers.

25641. ELEOCHARIS TUBEROSA (Roxb.) Schultes.

"Water chestnut."

From China. Procured by Mr. G. P. Rixford, of this Department, in San Francisco, Cal., from a Chinese importer. Received June 16, 1909.

"The corms or tuberous rhizomes of the above plant are a great favorite with the Chinese. They are mostly eaten raw, but are also sliced and shredded in soups and

25641—Continued.

in meat and fish dishes. Foreigners in China grate them and serve them boiled as a winter vegetable, in which state they resemble sweet corn very much in looks and taste.

"The plants need a hot summer to mature and are grown on a muck or clayey soil with several inches of standing water on top, very much in the same manner as wet-land rice." (*Frank N. Meyer.*)

Distribution.—A native of China, and extensively cultivated there for its tubers.

25642 to 25645. Vicia faba L. — Horse bean.

From Malaga, Spain. Presented by Mr. Charles M. Caughy, American consul. Received June 17, 1909.

Seeds of the following:

25642. *Morada.*

25643. *Cochinera* (pig).

25644. *Mazagana.*

25645. *Tarragona.*

"These beans are soaked for 12 hours and planted in land which is thoroughly irrigated. No further attention is paid to them until the stalks are about 2 feet high. They all occupy about the same time in ripening and in parts of the district there are 3 plantings a year, viz, September, December, and March.

"It is impossible to say anything as to their ability to resist frost, as that is not experienced here.

"The stalks are fed to stock without any preparation whatsoever except to cut them in short lengths, and have such little value that they are given to those who are willing to take them away." (*Caughy.*)

25646 to 25648.

From Yachow, China. Procured by Mr. H. J. Openshaw. Received June 16, 1909.

The following seeds:

25646 and 25647. Phaseolus vulgaris L.

25646. Mottled red.

25647. Black.

25648. Dolichos lablab L. — **Bonavist bean.**

Black.

25649 to 25658. Glycine hispida (Moench) Maxim. — Soy bean.

From Newchwang, China. Presented by Mr. Fred. D. Fisher, American consul. Received June 18, 1909.

The following seeds. Quoted notes by Mr. Fisher; descriptions of varieties by Mr. C. V. Piper.

25649 to 25651. "*Pai-mei* (white eyebrow), from the white scar on the saddle or point of attachment to the pod." These three numbers consist wholly, or mostly, of *Ito San.*

25649. (Locality unknown.)

25650. From Mukden.

25651. From Kwangning.

25652. "*Chin-huang* (golden yellow), from the golden color and more rounded shape of the bean." Subglobose yellow seeds with brown hilum.

25649 to 25658—Continued.

25653. "*Hei-chi* (black belly), from the dark-brown scar on the saddle." Yellow subglobose seeds with black hilum.

25654. "*Ch'ing-tou.* Epidermis green with inside yellow." Yellowish green subglobose seeds. Apparently identical with the *Morse* variety, No. 19186.

25655. "*Ch'ing-tou.* Both epidermis and inside green." Subglobose green seeds with black hilum and green embryo. Apparently the *Guelph* variety.

25656. "*Wu-tou.*" Small black seeds with yellow embryos. Apparently two varieties mixed.

25657. "*Hsiao-wu-tou* (small black bean); the bean is somewhat smaller than the following (S. P. I. No. 25658), with a black epidermis and yellow inside." Small black seeds with yellow embryos.

25658. "*Ta-wu-tou* (large black bean), where the epidermis is black and the inside green." Medium-sized, subglobose seeds, black with green embryos. Apparently identical with *Fairchild* variety, No. 19184.

25659. MANGIFERA INDICA L. **Mango.**

From province of Baliwag, Philippine Islands. Presented by Mr. Donald MacIntyre, Moanalua Gardens, Honolulu, Hawaii. Received June 19, 1909.

Caraboa. "The fruit of this is a little smaller than the one from *Cavite* (S. P. I. No. 24927)." (*MacIntyre.*)

25660. ZEA MAYS L. **Corn.**

From Alajuela, Costa Rica. Presented by Mr. Jerome B. Clark, care of Cox & Co., Hacienda "El Brazil." Received May 15, 1909.

White.

25665. SECALE CEREALE L. **Rye.**

From the province of Ekaterinoslav, Russia. Presented by Mr. J. A. Rosen, American Agricultural Bureau of the Government Zemstvo of Ekaterinoslav, Russia, 428 Andrus Building, Minneapolis, Minn. Received March 23, 1909.

Petkoff Winter. "This rye is frequently sown in the early part of July, is cut for soiling purposes in September (may also be pastured, but this is not advisable), and produces a crop of grain the following season. If raised for the grain only, it is sown late in September; in this case it usually yields heavier." (*Rosen.*)

25666 to 25683.

From Abyssinia. Presented by Mr. Hubert S. Smiley, Drumalis, Larne, Antrim County, Ireland. Received June 14, 1909.

The following seeds:

25666 to 25670. TRITICUM sp. **Wheat.**

25668. "Grown on clay ground in any part of the country."

25670. "White, grown in the hot country."

25671 and 25672. HORDEUM sp. **Barley.**

25671. "Grown on high ground."

25672. "Black. Grown on red earth in the cold part of the country."

25666 to 25683—Continued.

25673 and 25674. Hordeum vulgare L. **Barley.**

25674. White.

25675 to 25677. Andropogon sorghum (L.) Brot. **Durra.**

25675. "Common red-seeded durra of Abyssinia. Identical with No. 24897." (*Carleton R. Ball.*)

25676. "The common flinty-seeded durra of Abyssinia; seed yellowish, often tinged with brown; very similar to No. 24899. Seed poor and mixed." (*Carleton R. Ball.*)

25677. "Same as the above but seed of better quality. This variety has proved enormously heavy and late, as grown in the United States." (*Carleton R. Ball.*)

25678 and 25679. Vicia faba L. **Horse bean.**

25678. Brown.

25679. Greenish brown.

25680. Pisum arvense L. **Field pea.**

25681. Sesamum orientale L. **Sesame.**

Brown.

25682. Brassica sp.

25683. Phaseolus vulgaris L. **Bean.**

White.

25684 to 25686.

From Lawang, Java. Presented by Mr. M. Buysman. Received June 24, 1909.

The following seeds:

25684. Canarium commune L.

See No. 20808 for description.

Distribution.—A native of the Malay Archipelago, and cultivated in India.

25685. Mucuna sp.

25686. Mucuna sp. (?)

25688 and 25689. Belou marmelos (L.) W. F. Wight. **Bael.**

From Saharanpur, India. Presented by Mr. W. R. Mustoe, superintendent, Government Archæological Gardens, Lahore, Punjab, India. Received June 28, 1909.

Seeds of the following:

25688. Oblong variety.

25689. Small variety.

For further description, see No. 24450.

25690 and 25691. Pithecolobium dulce (Roxb.) Benth.

From Chinapas, Chihuahua, Mexico. Presented by Mr. Elmer Stearns, botanist, School of Agriculture, C. Juarez, Chihuahua, Mexico. Received June 24, 1909.

The following seeds:

25690. Fruit white.

25691. Fruit red or reddish.

See No. 23457 for description.

Distribution.—A native of Mexico, Nicaragua, and Colombia; cultivated in India and other tropical countries.

25692. CARICA PAPAYA L. **Papaw.**

From Gonda, United Provinces, India. Presented by Rev. N. L. Rocky. Received June 28, 1909.

"Papita or papaya seed grown in latitute 27° 7′ north, longitude 81° 51′ east. Fruit was about 4 pounds each; tree 16 months old. This seed came from fruit grown in Gonda, the seed of which I obtained originally in Bangalore. I have had trees live and bear for 6 years and continue to freely grow. I see no reason why this luscious fruit should not grow and thrive all along the Gulf and in the islands." (*Rocky.*)

25694. PITHECOLOBIUM DULCE (Roxb.) Benth. **Guamuchitl.**

From Guadalajara, Jalisco, Mexico. Purchased from Señor Hernandez, Street of the Giant 83½. Received June 28, 1909.

See No. 23457 for description, and Nos. 25690 and 25691 for distribution of this species.

25699 to 25701.

The following material received at the Upper Mississippi Valley Plant Introduction Garden, Ames, Iowa. Numbered for convenience in recording distribution, June 30, 1909.

25699. CYDONIA sp. **Quince.**

"(Iowa Expt. Sta. No. 518, 1906.) Seed received from Mr. Paul D. Bergen, Shantung, China. In his letter of October 2, 1906, Mr. Bergen says: 'The quince is the regular Shantung species, very good for jelly.'" (*S. A. Beach.*)

25700. MALUS sp. **Apple.**

"(Iowa Expt. Sta. No. 519, 1906.) Seed received from Mr. Paul D. Bergen, Shantung, China. In his letter of October 2, 1906, Mr. Bergen says: 'These apples are native to this district, and are a small, dark-red, sourish variety. Our climate here is milder considerably than that of Iowa. The country is here so completely cultivated that there is small place for wild fruits of any kind. The Chinese are considerably skilled also in the art of grafting, so that their fruits are very much modified from the ancestral stock.'" (*S. A. Beach.*)

25701. MALUS sp. **Apple.**

"(Iowa Expt. Sta. No. 432, 1906.) Seed received from Mr. H. P. Perkins, Poatingfu, China, October 12, 1906. In his letter of September 5, 1906, Mr. Perkins says: 'These are seeds saved from our breakfast apples, which were of 2 or 3 varieties, none of them equal to our best United States summer apples, and I fear they will not answer your purpose, as the winters here are probably far less cold than are yours. This place is near Shanhaikuan, which is the place where the great wall reaches the sea. The fruit region is some 40 miles north (Changli). There are hills there, but I imagine the fruit is grown not very far up the hillsides. We are on a sea bay which usually does not freeze over in the winter. We call all this part of China North China, but nothing inside the great wall is really very far north.'" (*S. A. Beach.*)

25702 and 25703. ORYZA SATIVA L. **Rice.**

From Saigon, Cochin China. Presented by Mr. Jacob E. Conner, American consul, at the request of consul-general Wilder, of Hongkong, China. Received June 28, 1909.

25702 and 25703—Continued.

Seed of each of the following:

25702. "The nearest we can come to identifying the rice described as *Sunejin* is a rice known to the merchants locally as *Sun tsim*, the translation of which is 'long kernel.' This rice is said to come from Anam." (*Wilder.*)

"The *Baixau*, as it is known here, is sometimes called 'Siamese garden rice,' and it commands the highest price in the market. A Chinese rice specialist here told me that it is known also as *Sun tsim*, which Mr. Wilder says corresponds to the *Sunejin*. At any rate, it is a fine rice to introduce." (*Conner.*)

25703. "The nearest we can come to the variety *Patma* is *Pat nor*, the translation of which is 'soft.' This rice is said to come from Tonkin." (*Wilder.*)

"This variety is called locally *Nep*, or 'alcohol rice,' is very dark colored, and is the one I suppose which corresponds to *Patma* and Mr. Wilder called *Pat nor*." (*Conner.*)

25704 to 25716.

From Poona, Bombay, India. Presented by Mr. M. A. Peacock, Pennellville, N. Y. Received June 24, 1909.

The following seeds:

25704. DOLICHOS BIFLORUS L.

25705. PHASEOLUS MAX L.

Black.

25706. PHASEOLUS RADIATUS L.

Green and brown mixed.

25707. PHASEOLUS ACONITIFOLIUS Jacq.

Brown.

25708. CYAMOPSIS TETRAGONOLOBA (L.) Traub.

25709. CAJAN INDICUM Spreng.

Mauve.

25710. LENS ESCULENTA Moench. **Lentil.**

25711. PISUM ARVENSE L. **Field pea.**

Mottled green.

25712. LATHYRUS SATIVUS L.

25713. CICER ARIETINUM L. **Chick-pea.**

25714. VIGNA UNGUICULATA (L.) Walp. **Cowpea.**

Mixed brown and cream colored seed.

25715. STIZOLOBIUM sp.

Mottled gray and brown.

25716. GLYCINE HISPIDA (Moench) Maxim. **Soy bean.**

Yellow.

25717. SCHINOPSIS BALANSAE Engl.

From Chaco, Argentina. Presented by Sr. Ing. D. Carlos D. Girola, University of Agriculture, Santa Fe, Buenos Aires. Received June 19, 1909.

"A tree belonging to the family Anacardiaceæ. Native in Paraguay, where, according to Engler, it grows on river banks in impervious clay soil. Said to occur also in eastern and southern Argentine. Known locally as *quebracho colorado*, and forms one of the sources of the quebracho extract used in tanning." (*W. W. Stockberger.*)

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 169.

B. T. GALLOWAY, *Chief of Bureau.*

VARIEGATED ALFALFA.

BY

J. M. WESTGATE,
Agronomist in Charge of Alfalfa and Clover Investigations,
Forage-Crop Investigations.

Issued February 3, 1910.

239494
13.1.30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

BUREAU OF PLANT INDUSTRY.

Chief of Bureau, BEVERLY T. GALLOWAY.
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., October 9, 1909.

SIR: I have the honor to transmit herewith and to recommend for publication as Bulletin 169 of the special series of this Bureau the accompanying manuscript, entitled "Variegated Alfalfa." This has been prepared by Mr. J. M. Westgate, Agronomist in Charge of Alfalfa and Clover Investigations, Forage-Crop Investigations, and has been submitted by the Agrostologist in Charge of Forage-Crop Investigations with a view to publication.

The studies made in connection with the comparative tests of alfalfa varieties have disclosed a hardy, drought-resistant race which apparently owes its origin to the crossing of ordinary alfalfa with the hardy, yellow-flowered alfalfa of Europe and Asia. In addition to its superior hardiness and drought resistance it possesses other characteristics which serve to distinguish it from ordinary alfalfa. The possibilities of this group of variegated alfalfas for use in extending the production of the crop in sections where the climate is too severe for ordinary alfalfa, together with its great variability, which affords excellent opportunities for breeding and selection, make the publication of these studies desirable.

Very respectfully,

A. F. WOODS,
Acting Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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VARIEGATED ALFALFA.

INTRODUCTION.

In connection with investigations concerning alfalfa there have appeared from time to time isolated instances of fields which have been notably superior to near-by fields of ordinary alfalfa. In one instance, namely, the Grimm alfalfa of Minnesota, the progeny of a single field has spread and attracted much merited public attention by reason of its hardiness. Special attention has naturally been called to such fields as are located in sections where ordinary alfalfa is not altogether successful. Comparative studies have shown that these fields agree in showing a considerable percentage of flowers of some other color than the violet of ordinary alfalfa. Fields which resemble these hardy fields in general appearance have also been discovered in the recognized alfalfa districts, but they have attracted much less attention owing to the success of ordinary alfalfa in such districts. A study of such strains as have become more or less well known, together with several isolated fields, has revealed the fact that they may all be classed in the same botanical category as "variegated alfalfa." The agronomic tests, while not completed as yet, indicate that from similar sources these variegated strains are hardier than the nonvariegated strains. The designation "hardy alfalfa" has already been applied in part to two of the strains under consideration, Grimm alfalfa and commercial sand lucern. The alfalfas which have been identified with this group are Grimm alfalfa, commercial sand lucern, and much of the so-called Canadian alfalfa, together with a number of less well-known strains.

In addition to the fields of hardy alfalfa which have commanded attention in this country and Canada, it has been found that certain regional lots, secured chiefly from central European sources, possess the same characteristics and assist materially in explaining the origin of the entire group. Investigations concerning the history and characteristics of this alfalfa indicate its probable origin and afford a logical explanation of the remarkable variations that it presents.

Variegated alfalfa has apparently originated by the natural hybridizing of ordinary alfalfa with the hardy yellow-flowered alfalfas of

Eurasia. The natural hybridizing of the two species has given rise to a series of crosses which have subsequently intercrossed among themselves and with the original parental stocks, especially ordinary alfalfa, the pollen of which is probably prepotent. In this way there has been produced a group of multiple crosses which present a mass of widely varying forms. These, while showing much diversity in appearance, include a considerable proportion which possess the ability to withstand cold, drought, and unfavorable soil conditions better than ordinary alfalfa.

The hybrids have apparently been produced wherever the two parents have come in contact. These forms, as evidenced by the variation in the flower color, are reported to have been noted by the Swiss botanist, Casper Bauhin, who was born in the year 1560 and died in 1624.[a] This observation was made in southern France, but the perfect success with which ordinary alfalfa is produced there gave little opportunity for the establishment or recognition of hardy races by selective acclimatization, as has been the case under more severe climatic conditions, where the hybrid forms possess advantage over the ordinary alfalfa. A study of the parental species and their hybrids is necessary to indicate the relationships of "variegated alfalfa."

THE YELLOW-FLOWERED FALCATE-PODDED ALFALFA (MEDICAGO FALCATA, L.) AND ITS ALLIES.[b]

An examination of several different introductions of yellow-flowered alfalfa secured from various points in Europe and Asia indicates that there are several forms to be recognized. These have usually been grouped under the one species, *Medicago falcata*, and as far as the purposes of the present bulletin are concerned they may be so treated here. The original binomial description of *Medicago falcata* is very short and states simply that the peduncles which bear the racemes of flowers are arranged racemosely on the stalks, the pods crescent shaped, and the stems prostrate.[c] The flowers of this species are uniformly yellow and are borne in racemes of from five to twenty flowers each. The pedicels average about one-fourth longer than the calyx tubes, while the calyx teeth average about one-sixth longer than the calyx tubes. The pods are sickle shaped, reticulately veined, and generally very dark colored when mature. The three leaflets vary from obovate to linear cuneate and are usually either deeply notched or mucronate at the apex. Many of the plants show a tendency to produce occasional leaves with supernumerary leaflets. The decumbent or prostrate stems show a decided tendency to be four angled and are somewhat woody at the base when old. (See Pl. I, fig. 1.) The variations noted in the different forms are principally in the shape of the leaves and flowers and in the habit of growth of the individual plants, which vary from prostrate to ascending. The species is widely distributed throughout Europe, except in the extreme north, and extends eastward at least to the Baikal Mountains in eastern Siberia.[a] It has also been reported from China.[b] It normally grows in rather exposed and unfavorable situations. Where it occurs in any considerable quantity it is sometimes mown for hay. Instances are on record where seed of the wild plants have been gathered and the resulting plants domesticated.[c]

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[a] Martyn. Flora Rustica, 1792, vol. 3, p. 87; also Pinax, p. 330.

[b] Hansen, N. E. The Wild Alfalfas and Clovers of Siberia, with a Perspective View of the Alfalfas of the World. Bulletin 150, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1909.

[c] Medicago pedunculis racemosis, leguminibus lunatis, caule prostrato. Linnæus, Species Plantarum, 1753, vol. 2, p. 779, and Flora Suecica, par. 620; also Dalibard, Floræ Parisiensis Prodromus, Paris, p. 229.

The chief drawbacks to the agronomic utilization of this species are its poor seeding habits, its light yield of hay, and the tendency of its stems to be prostrate or procumbent. The quantity of seed produced by the plants is not only small, but it shatters badly. The principal value of this species lies in its power to withstand severe conditions as regards soil and climate, as it is thus enabled to grow on soils unfavorable to the successful growth of ordinary alfalfa. Its ability to thrive under severe conditions without reseeding for long series of years has been a matter of note.[d]

The rôle that *Medicago falcata* has played in hybridizing with the ordinary alfalfa and producing progeny combining the desirable characteristics of both parents is of great agronomic importance.

ORDINARY ALFALFA (MEDICAGO SATIVA, L.).[e]

The original binomial description of *Medicago sativa* states that the peduncles bearing the flower racemes are arranged racemosely on the stems, the pods coiled, and the stems erect and glabrous.[a] The flowers of this species are normally violet and are borne in racemes of from eight to twenty-five flowers each. The pedicels average about two-fifths shorter than the calyx tubes, while the calyx teeth average about one-third longer than the calyx tubes. The pods are coiled two to four times in close spirals, are delicately veined, and brown in color when mature. The three leaflets are usually obovate to lanceolate and are toothed or dentate toward the apex. The individual plants show but slight tendencies to produce leaves with supernumerary leaflets. The stems are nearly erect, show little tendency to become woody when old, and are slightly inclined to be four angled. (See Pl. I, fig. 4.)

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[a] Stebler and Volkart. Die besten Futterpflanzen, 3d ed., 1908, p. 105.

[b] Bretschneider. History of European Botanical Discoveries in China, vol. 2, p. 859.

[c] Metz and Co. Berichte über Nutzpflanzen, Berlin, 1868, p. 13. In the account given it is noted that seed was gathered from plants growing in exposed situations and from very sterile soil. The seed was sown in part on poorly drained and in part on thin, dry soil. The results were very satisfactory and the seedings were continued, as ordinary alfalfa had been found unable to succeed under the conditions present.

[d] Stebler and Volkart, loc. cit. These authors state that a local seeding made at Zürich, Switzerland, in 1885 was still standing in 1908, while ordinary alfalfa planted at the same time disappeared after six years. Another seeding of *Medicago falcata* made on the experimental field at Furstenalp, Switzerland, 1,780 meters above sea level, had in 1908 lasted twenty years, in spite of the rough situation and damp soil and without having reseeded itself.

[e] See Coburn, F. D., The Book of Alfalfa, 1906; Scofield, C. S., The Botanical History and Classification of Alfalfa, Bulletin 131, pt. 2, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1908; Westgate, J. M., Alfalfa, Farmers' Bulletin 339, U. S. Dept. of Agriculture, 1908; and Wing, Joseph E., Alfalfa Growing in America, 1909.

This species, whose probable original home was in Persia, has since become widely spread, especially in those parts of the temperate world where agricultural operations are important. Its extension into the sections occupied by the wild forms of the yellow-flowered alfalfas is of special significance in connection with the studies as to the multiple origin of the hybrid variegated alfalfas. The agronomic value of alfalfa is probably second to that of no other forage plant in the world. It is possessed of a wide adaptability to different climates and soils, but unfortunately is not able to withstand the severe conditions presented by some of the agricultural districts, especially along the northern border of successful agricultural operations, where the winters are severe, and in the semiarid regions, where the lack of sufficient moisture prevents the production of profitable crops of hay. This lack of complete adaptation to all agricultural districts has handicapped the extension of ordinary alfalfa over large sections where only a slight increase in hardiness or drought resistance would enable it to be successfully produced.

HYBRID INTERMEDIATE FORMS OF ALFALFA (MEDICAGO SATIVA VARIA (MARTYN) URBAN; MEDICAGO FALCATA × MEDICAGO SATIVA, REICHB.).[b]

There has been much confusion in botanical literature in regard to the proper classification of the many varied forms of alfalfas which have appeared where the ordinary alfalfa and the yellow-flowered species have been associated.[c] The nonstability of the different forms readily accounts for this botanical confusion. The first botanical description of what appears to be this hybrid was by Martyn, whose description concerns itself principally with the noteworthy variation to be observed in the flowers of the different individuals, as follows:[a]

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[a] Medicago pedunculis racemosis, leguminibus contortis, caule erecto glabro. Linnæus, Species Plantarum, 1753, vol. 2, p. 778, and Hortus Cliffortianus, p. 377; also Royen, Floræ Leydensis Prodromus, p. 281.

[b] In the present publication the term "intermediate" is used to designate the forms occupying the middle third of the space between the two parents as regards their general characters.

[c] Stebler and Volkart, loc. cit.

> *Medicago varia* (species or rather variety).—Various flowered medick. Yellow medick varies much in the color of its flowers, which are sometimes whitish, quite white, or greenish. The variety here figured is remarkable in having flowers of colors so different as blue and yellow on the same stalk. Casper Bauhin says that it is found in the south of France with whitish yellow, green, blue, purple, black, and variegated flowers, but he does not affirm that these different colors are on the same plant. Mr. Ray observed it with a purple flower, between Norwich and Lynn, and doubted whether it was not the true lucern in a wild state. The stipules are narrower in this than in the foregoing [*Medicago sativa*], but whether this difference be permanent or not we can not say.

The next botanical description that in all probability refers to one of the hybrid forms is the *Medicago media* of Persoon; at least botanists have generally considered that Persoon's description refers to the hybrids between *Medicago sativa* and *Medicago falcata*. This name has had common acceptance in many floras, but owing to the priority of the name assigned by Martyn this has come to be recognized as a synonym of *Medicago sativa varia*. In the description of *Medicago media* the characteristics are noted as follows: The peduncles bearing the flower racemes are arranged subcorymbosely on the stems; the flowers are pale blue, but at length become yellowish; the leaves are wedge shaped to linear, notched or retuse at the apex and hairy beneath.[b]

Among the other names which have been assigned to these forms are *Medicago sativa* L., var. *versicolor* Ser.; *Medicago falcata* L., var. *hybrida* Gaud.; *Medicago falcata* × *Medicago sativa* Reichb.; and *Medicago intermedia* Schultes.[c] These forms appear in most respects to be intermediate between the two species just discussed. The flowers, however, show a great tendency to vary in color, especially on different plants. In addition, the color in the individual flower is apt to show a progressive change in color as it becomes older. The flowers of a single individual may, in fact, run the gamut of variation from violet through blue and green to yellow. The racemes are 5 to 20 (rarely 25) flowered. The pedicels average about equal to the calyx tubes in length, while the calyx teeth average one-fifth longer than the calyx tubes. The pods are loosely coiled in from one-half to two turns, are reticulated, and dark brown in color when mature. The leaflets are oblong lanceolate and very frequently are either deeply notched or mucronate at the apex. The leaves often show supernumerary leaflets. The stems vary from decumbent to ascending, are slightly woody at the base, and rather strongly inclined to be four angled. (See Pl. I, figs. 2 and 3.) These hybrids occur apparently wherever the two parents have been associated when seed production was possible and in some instances have spread to other sections.[a] These intermediate forms possess the same disadvantages as does the *Medicago falcata*, although to a somewhat less degree. The stems are too prostrate to be mown easily. The seeding habits, while much better than those of *Medicago falcata*, are not equal to ordinary alfalfa, and in any but situations too unfavorable for the growth of ordinary alfalfa they are not to be recommended.

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[a] Martyn. Flora Rustica, 1792, vol. 3, p. 87.

[b] Persoon. Synopsis Plantarum, 1807, vol. 2, p. 356. "*Medicago media*, pedunc. subcorymbosis, flor. pallide cæruleis demum flavescentibus, foliol. cuneato-linearibus retusis apice dentatis, subtus pilosis. * * * In pratis, collibus et ad versuras agror."

[c] Stebler and Volkart, loc. cit.

There has always been more or less confusion as to the identity of the many forms, owing in part to their nonstability and also to the readiness with which they intercross with each other, and especially with ordinary alfalfa, and thus approach the ordinary variety more closely in their characters than do the intermediate hybrid forms. The subsequent intercrossing has been mainly with ordinary alfalfa, owing to its very common culture, and this has brought about forms which closely resemble ordinary alfalfa, but which retain much of the hardiness of the yellow-flowered ancestor, while possessing its disadvantages to only a slight degree.

VARIEGATED ALFALFA.

The designation "variegated alfalfa"[b] is intended to comprise the progeny of the intermediate hybrid forms just discussed, which have been recrossed several times with ordinary alfalfa and also among themselves. The mixed hybrid shows in each of its characters some relation to both parents, but the characters much more closely approach those of ordinary alfalfa than they do the yellow-flowered species. (See Pl. III, figs. 2, 3, and 4.)

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[a] Stebler and Volkart, loc. cit.

[b] It is difficult to designate botanically the maze of widely varying forms here called variegated alfalfa. They range from those which are strictly intermediate between *Medicago sativa* and *M. falcata* to forms which so closely resemble *Medicago sativa* as to be optically indistinguishable from the latter. The designation "*Medicago falcata* ×< *Medicago sativa*" would be in accordance with both the American and Vienna codes of botanical nomenclature for a hybrid which resembles the *Medicago sativa* parent more closely than it does the *Medicago falcata*. This, however, does not indicate the repeated recrossing of *M. sativa varia* which has apparently occurred with *M. sativa* as the male parent. The designation "*Medicago falcata* × (*M. sativa*)^{n}" would indicate the apparent true relationship of these plants. The group lying between the strictly intermediate forms and *Medicago sativa* has been designated "*Medicago varia pseudo-sativa*" by Rouy and Foucaud in Flore de France, with the following synonymy: *M. sativa β. versicolor* Koch, *M. spuria* Hy., *M. cyclocarpa* × *sativa* Hy., *M. sativa* > *falcata* R. and F. It is not desired, however, in the present publication to do more than to call attention to the facts as they appear.

The flowers are predominantly violet, but normally about one-third show the variation in color as described for the intermediate forms. The flowers are borne in racemes of from 5 to 25 flowers each. The peduncles bearing the racemes are normally borne as in ordinary alfalfa, but they sometimes approach the subcorymbose habit referred to in the original description of *Medicago media*. The pedicels are usually about one-third shorter than the calyx tube, while the calyx teeth are about one-fourth longer than the calyx tube. The pods are coiled in from 2 to 4 (rarely ½ to 1) spirals, somewhat looser than in ordinary alfalfa, and are of a darker brown color when mature. The three leaflets are obovate to lanceolate and are frequently deeply notched or mucronate at the apex. The individual plants show a decided tendency to produce leaves with supernumerary leaflets. The stems are ascending, but possess a tendency to lodge (see Pl. II, figs. 1 and 2) and are slightly coarser than the ordinary alfalfa and strongly inclined to be four angled. The present geographical distribution of the different strains of variegated alfalfa has not been entirely worked out, but most of the introductions can be traced to parts of Eurasia where the two parental forms occur and where the conditions are not entirely favorable to the successful production of ordinary alfalfa. The principal introductions have been secured from the Rhenish provinces, Bohemia, and eastward, but usually north of the forty-ninth parallel of latitude.

The handicaps under which the intermediate forms labor—procumbent growth, poor seeding habits, and relatively light yields—have been overcome in these forms by the influence of successive crossing with the ordinary alfalfa. They retain, however, sufficient of the yellow-flowered alfalfa parentage to make a considerable proportion of the individuals decidedly more hardy than the ordinary alfalfa.

The characteristics of variegated alfalfa will be more fully discussed under the heading "Comparison of the different strains of variegated alfalfa and their parents."

STRAINS OF VARIEGATED ALFALFA.

The wide distribution of the yellow-flowered alfalfa in Eurasia has resulted in ordinary alfalfa being brought into contact with it at many places and has thus given rise to many independent sets of hybrids. These different forms as a whole agree rather closely in their botanical characteristics, but differ one from another in the climatic conditions to which they have been subjected and also in the amount of subsequent recrossing with either or both of the original parental forms. The three most important strains and the only ones which have been given severe tests for hardiness are the Grimm alfalfa, which has been grown successfully in Minnesota since 1858, Canadian alfalfa (in part), and the commercial sand lucern (in part). Several small lots of seed have shown very close botanical relationships to the forms just mentioned and have some direct claims to hardiness on account of the severe climatic conditions characterizing the regions from which the seed has been procured. They have not, as a rule, however, been rigorously tested as yet under field conditions in this country.

COMMERCIAL SAND LUCERN.

The term "commercial sand lucern" is used in the present publication to designate the alfalfa recognized by various seed houses in Europe and America as sand lucern. The necessity for this distinction is occasioned by the fact that the commercial sand lucern of to-day is quite different from the early forms of sand lucern referred to by European writers. The original sand lucern is properly classed with the preceding category of intermediate forms of alfalfa; that is, the first or early generation hybrids between *Medicago sativa* and *Medicago falcata*. The commercial sand lucern has, on the other hand, been so materially modified by repeated crossing with ordinary alfalfa as to be classed in the category of variegated alfalfa. (See Pl. II, fig. 1.) It is necessary to give a brief account of the history of the original sand lucern to indicate the origin of the commercial sand lucern of the present time.

History of the early forms of sand lucern.—There is some confusion in the literature regarding sand lucern, owing apparently to its unstable character when grown for successive generations near either the yellow-flowered alfalfa or the ordinary alfalfa. It may have had its origin in any one or all of three ways: First, the seed of natural hybrids may have been gathered and seeded.[a] Miller describes one instance of its early domestication in England as follows:[b]

> Thomas Le Blanc, esq. of Cavenham in Suffolk, having been struck with the luxuriance of the yellow Medick in the poorest soils, determined to have the seed gathered, in order to cultivate it. Whilst engaged in this pursuit, he happened to find the variegated Medick, and observing it to be more luxuriant even than the yellow, it commanded his attention.
>
> It is less erect, he says, and less succulent than Lucern; but more succulent and much more luxuriant than the yellow Medick. The seed pods partake of the shape of each, being less twisted than those of Lucern, but more so than those of yellow Medick. The flowers are beautifully varied in every shade of blue and greenish

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[a] Stebler and Volkart, loc. cit.

[b] Miller. Gardener's and Botanist's Dictionary. 1807.

yellow, and some are almost white. His reasons for preferring it to Lucern are, that it is hardier in bearing cold, that from its habit of branching below the surface of the ground, and the shoots being much more numerous, it is not choaked by natural grasses, and that for the same reason it will not be injured by being fed with sheep, and that it grows spontaneously upon the poorest soils.

In 1783 he began with a single plant, which he transplanted into his garden, the soil of which is a blowing sand. In 1784 he gathered the seed of it, and in April 1785 he sowed with it a bed consisting of five rows, thirty-nine feet long. The plants came up thick and strong; some of them blossomed at the beginning of July in the same year, and measured above two feet in height. Although all the seeds were gathered from one plant, yet the flowers differed very much in colour; some being almost yellow, some almost white, and others purple of various shades. In August the same year he took up the same seedlings, six thousand six hundred in number, and transplanted them. Some of them measured two feet and a half in height. Most of the roots were cut through with the spade; one which was pulled up measured two feet nine inches in length. He likewise dug up a few wild plants, which he divided into a great number of slips, every one of which grew. * * *

The 4th of December the plants were not affected by the frost; at the same time the shoots of Lucern were entirely destroyed. * * *

In June 1789 Le Blanc's Medick was in blossom before the Lucern, and much fuller of flower. Both the transplanted and sown flowered luxuriantly; he saved it for seed, but it produced a very small quantity; in November he dressed it with ashes.

May the 26th 1790, he cut a square yard of Lucern, and an equal measure of the Medick adjoining; the Lucern was tallest, and appeared the larger bundle, but upon weighing them, the Lucern was three pounds three quarters, the Medick four pounds and a quarter. The crop of Medick was very fine, and had the appearance of having been sown broadcast, the intervals being so filled up, that the drills could not be distinguished, whereas the rows of the Lucern were very apparent. * * *

Mr. Young remarks upon this very satisfactory account of the introduction of a new plant into culture, that may bid fair to rival Lucern itself, that Mr. Le Blanc's farm at Cavenham being on a poor blowing sand, he has very happily fixed on a plant which appears to thrive better on such sand than in richer soils. Mr. Young tried it in moist loams, worth 15s. an acre, but never could get the plants to do so well as on the poorest sands.

The second possible origin is that the seed of the wild yellow-flowered alfalfa (*Medicago falcata*) may have been gathered and seeded near plants of ordinary alfalfa when hybridizing would normally take place, producing the intermediate forms.[a] A third possibility is that natural hybrids may have occurred in fields of ordinary alfalfa and that the resulting hybrid forms have been perpetuated in preference to the ordinary alfalfa either by unconscious natural or artificial selection. That the second method, namely, that the original selections were *Medicago falcata* and that they may have formed an important early source, is substantiated by the apparent early impression that sand lucern should show only yellow flowers.[b] Further, the name "Swedish alfalfa" has been applied both to the wild yellow-flowered alfalfa and to the hybrid forms between this and the ordinary alfalfa.[a] Stebler and Volkart[b] state that according to Ascherson the seed of the original sand lucern was first gathered on the "barren heights of Eifel."[c] This was presumably before 1841, since the same account states that its culture could not have assumed much importance by that time, since J. Metzgar, in his thorough work on agricultural plants, dated 1841, knew nothing of its culture.

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[a] Metz & Co. Berichte über Nutzpflanzen, Berlin, 1868, p. 13. Stebler and Volkart, loc. cit.

[b] Metz & Co., loc. cit.

Intermediate alfalfa did not attract particular attention agriculturally until 1842, when its ability to withstand the severe drought of that year in Germany brought it to the attention of agricultural writers.[d] It may have been cultivated first in Sweden,[e] but it could not have much preceded the first trials of it in Germany, since the culture of ordinary alfalfa in Sweden can not with certainty be traced farther back than 1840, when it was seeded at one of the experiment stations.[f] Practically all of the European accounts of the original sand lucern are based upon the showing made by it on the poorer classes of soils, both sand and clay, in France, Germany, and eastward. These accounts have made little or no note of the fact that under cultivation in association with ordinary alfalfa it intercrosses with that and more and more closely assumes the characters of the latter. This passing into forms closely approaching ordinary alfalfa has gone so far that it is exceedingly difficult to obtain through commercial sources even small quantities of the seed of the truly intermediate forms. The different lots of commercial sand lucern imported into this country have never, so far as observed, shown more than a very small percentage of intermediate forms strictly comparable with the original sand lucern. On the other hand, the relationship to both parents is generally indicated in some way on the part of the individual plants, although they quite closely approach ordinary alfalfa in general appearance. Stebler and Volkart[g] state that their tests of commercial sand lucern proved to be mostly "blue lucern."[a] This opinion as to the cause of the gradual approach of the intermediate hybrid forms to ordinary alfalfa by successive recrossing where the two are grown near together confirms the results of the experiments discussed under the heading "Re-creation of variegated alfalfa," page 33.

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[a] Pinckert, F. A. Anleitung zur Cultur und Benutzung des Bastardklees, der Sandluzerne und Esparsette als bodenbereichernde Futterkräuter. 1860.

[b] Loc. cit.

[c] The heights of Eifel are located a few miles west of the Rhine River and about 35 miles south of Koln (Cologne), Germany.

[d] Pinckert, F. A., loc. cit.

[e] Pinckert, F. A., loc. cit. Bisher wurde dieselbe am meisten in Schweden angebaut, ein Beweis, dass sie auch bei uns in den nördlichen Gegenden sicher gedeihen wird. Bei uns sind die meisten Versuche ihres Anbaues in den Rheingegenden gemacht worden, wo sie zuerst von v. Arnstädt in Gr.-Kreutz eingeführt wurde. Dort ist namentlich die Sandluzerne im Grossen auf einzelnen Gütern in der Rheinprovinz und zwar im Kreise Rees angebaut worden, desgleichen hat sie sich auch im Kreise Simmern auf allen Bodenarten gut bewährt.

[f] Kongl. Landtbruks-Akademiens Handlingar och Tidskrift, 1893, p. 292.

[g] Loc. cit.

It is possible that another important factor in bringing the intermediate forms to forms so closely resembling the ordinary alfalfa is that owing to the higher price of the seed of the original sand lucern it has been adulterated with seed of ordinary alfalfa, which intercrossed with the original sand lucern and thus produced a mongrel progeny with the characters of the ordinary alfalfa predominating. The relatively small amount of sand lucern seed produced in some sections may have led to its being bulked with the seed of ordinary alfalfa, with similar results. The original sand lucern does not at present appear to possess much importance agronomically, as it is practically impossible to obtain the seed commercially even for small experimental plots. Its chief value lies as breeding stock, and it can be readily produced by growing the two parents side by side under conditions which favor the setting of seed. The commercial sand lucern is, on the other hand, of considerable agronomic importance, and it is with this kind of seed almost without exception, rather than with the intermediate forms, that the tests have been carried on under the name of "sand lucern" in this country by private individuals, by the state agricultural experiment stations, and by the United States Department of Agriculture.

Results with sand lucern in America.—It is only within the past two decades that attention has been given to experimenting with sand lucern in the Western Hemisphere. One reason for this is the fact that most of the various experiment stations were not organized before that time. A more potent reason, however, is the handicap of the name under which this variety labored. It was called "sand lucern" from its ability to grow on certain poor sandy soils of Germany, and it has been pointed out that it might equally as well be called "clay lucern."[b] In parts of Europe it has been designated as "hardy alfalfa," and had Europe possessed such large areas of cultivated land requiring a hardy or drought-resistant alfalfa as does our own country it is probable that the value of this form would have been appreciated at a much earlier date. Furthermore, the European accounts have dealt mainly with the original forms of sand lucern, which it was admitted could not compete with ordinary alfalfa under conditions to which ordinary alfalfa is adapted. The disadvantages of the nearly prostrate habit of these intermediate forms were pointed out, together with their rather poor yielding qualities. These handicaps served in the aggregate to retard interest in both the original intermediate form and in the commercial sand lucern. Its exploitation has thus been correspondingly retarded.

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[a] The term "blue lucern" is sometimes used to designate the alfalfa commonly produced in Germany. As will be pointed out under the heading "German alfalfas," the German-grown alfalfas normally possess a considerable percentage of blue blossoms in addition to the ordinary violet-colored blossoms characteristic of ordinary alfalfa.

[b] Metz & Co. Berichte über Nutzpflanzen, Berlin, 1868, p. 89.

Under the name "lucerne rustique" or "hardy alfalfa" the sand lucern, probably the commercial form, was tested in Brazil in the latter years of the nineteenth century.[a] Under the tropical conditions present it was outyielded by the Provence alfalfa, with which it was compared. The yield for the first four of the seven cuttings procurable during the long growing season was at the rate of 6,057 pounds to the acre for the Provence alfalfa as compared with 5,255 pounds for the sand lucern. In Canada, on the other hand, the tests carried out showed the sand lucern to be superior to the ordinary alfalfa.[b]

In the United States, tests of sand lucern have been made at a number of different points. It was grown in 1889 in Delaware[c] and in 1892 near Baton Rouge, La.[d] In the tests made in Delaware it was injured by the leaf-spot (*Pseudopeziza medicaginis*), as was also the ordinary alfalfa. In Louisiana it was choked out by the native grasses.[e] Herbarium material taken at the Mississippi Agricultural Experiment Station in 1892 indicates that it was under test there at that time.[f] In small plot tests commenced in North Carolina in 1891 and reported in 1894, sand lucern succeeded under the unfavorable conditions present somewhat better than did the ordinary alfalfa.[g]

Probably the most noteworthy early trial of commercial sand lucern in this country was made by the Michigan Agricultural Experiment Station commencing in 1897. One-sixth acre of light sandy soil was seeded to the sand lucern and the cured hay weighed during the four succeeding years. The surface soil had for the most part been removed by grading, and the soil on which the seed was sown was so sandy as to be somewhat drifted by the wind. The calculated yields per acre, based on the yields obtained from the one-sixth acre plot, are given below:

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[a] Boletim do Instituto Agronomico do Estado de São Paulo em Campinas, no. 8, vol. 10. 1899.

[b] Bulletin 46, Central Experimental Farm, Ottawa, Canada. 1904.

[c] Second Annual Report, Delaware Agricultural Experiment Station, 1889, p. 16.

[d] Bulletin 19, second series, Louisiana State Experiment Station. 1892.

[e] This is also usually the fate of ordinary alfalfa seeded under similar conditions in the same section.

[f] The specimen is now deposited in the herbarium of the Michigan Agricultural College.

[g] Bulletin 98, North Carolina Agricultural Experiment Station. 1894. The statement, "Resembles lucern, but plant does not grow so high; flowers mostly yellow," would indicate that it was the intermediate form and not the commercial sand lucern that was under test.

Year.	Cuttings.	Cured hay per acre.
	Number.	*Pounds.*
1898	3	6,800
1899	4	10,580
1900	4	12,310
1901	4	13,839
Total for four years		43,529

The ordinary alfalfa seeded on the station grounds at the same time was so badly winterkilled that it was plowed under. The winter of 1898–9 was especially severe at the Michigan station, and wheat, clover, fruit trees, and other hardy plants were killed. The sand lucern was practically uninjured, although the thermometer registered temperatures as low as −24° F.[a]

The Michigan Agricultural Experiment Station, in another alfalfa variety test started in 1903, compared the merits of sand lucern, Turkestan alfalfa, and alfalfa from Germany with American-grown seed. In the spring of 1905[b] the sand lucern and Turkestan plots were notably better than the others. The American-grown seed was badly winterkilled, while the Turkestan alfalfa maintained an almost perfect stand. The Colorado alfalfa was visibly poorer than the sand lucern and Turkestan alfalfa. The minimum temperatures for the winter of 1904–5 were −18° F. on December 14, 1904, and −16° F. on February 15, 1905. The sand lucern was also tested at the Michigan Upper Peninsula substation. It gave slightly larger yields than did the German alfalfa, which stood second in rank as to yield in the test of several varieties. Unfortunately, however, the tests were not strictly comparable, owing to variation in the ground and also in the stand secured.

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[a] The winterkilling noted in Michigan in 1898–9 appears to have been due quite as much to the unusual conditions as regards precipitation and relatively high temperatures in January as to the actual minimum temperatures. The months of December and January were exceptionally warm. Until January 28 no temperatures were registered below 0° F. On January 28 there commenced a series of minimum temperatures below zero which continued until February 14, with the exception of February 2, 3, and 4. These low temperatures reached their absolute minimum on February 12, when −24° F. was registered. The customary heavy winter snows did not commence until March. The snowfall up to January 13 had been 8.25 inches, distributed over six different days. This was presumably melted, since on January 13 there was 0.65 inch of rain, with a minimum temperature of 36° and a maximum temperature of 40° F. From January 13 until the extremely cold weather above noted set in on January 28 there were but 1.8 inches of snow, distributed over four nonconsecutive dates. It will thus be seen that the lack of snow protection was combined with the preceding relatively warm weather, by which the evil effects of the low temperatures were increased. It is worthy of note that during this same winter the fields of ordinary alfalfa were winterkilled in central Minnesota, while the Grimm alfalfa fields were uninjured. See Annual Report, Minnesota Agricultural Society, 1903.

[b] Bulletin 225, Michigan Agricultural Experiment Station. 1905.

Another series of experiments was inaugurated at the Michigan Agricultural Experiment Station in the spring of 1905 in cooperation with the United States Department of Agriculture. The plantings were made both at the central experiment station grounds and also at the substation of the Upper Peninsula. At the latter place the first series of five varieties was seeded on a plot which had been intensively cultivated so as to be entirely free from quack-grass and weeds. The yields per acre secured in 1906 were as follows:

	Pounds.
Sand lucern (commercial) (variegated)	7, 680
Colorado alfalfa (S. P. I. No. 12398)	7, 360
New York alfalfa (S. P. I. No. 13291)	6, 880
Nebraska alfalfa (S. P. I. No. 12820	7, 360
Arizona alfalfa (S. P. I. No. 13437)	6, 720

The next series of five varieties was seeded at the same time upon an adjoining plot which had been in buckwheat in 1904. The presence of much volunteer buckwheat made hand weeding necessary to save the alfalfa plants. This may have affected the yields of this series so as to make it not strictly comparable with the figures just presented.

The reported yields are as follows:[a]

	Pounds.
Wyoming alfalfa (S. P. I. No. 13489)	4, 480
Minnesota alfalfa (S. P. I. No. 13438)	4, 000
Canadian alfalfa (S. P. I. No. 13436) (variegated)	6, 080
Northern Montana alfalfa (S. P. I. No. 13237)	4, 160
Kansas alfalfa (S. P. I. No. 13440)	2, 720

There appears to be no question as to the fact that the sand lucern under test was the commercial form rather than the early intermediate form. In Bulletin 198 of the Michigan Agricultural Experiment Station the following statement is made:

> In appearance and behavior the difference between the sand lucern and alfalfa is so very slight that only an expert botanist could note the botanical characteristics which distinguish each, and a most careful observer could discern wherein one differs from the other.

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[a] Bulletin 198, Michigan State Agricultural Experiment Station: "Sand lucern has the special advantage over alfalfa of being able to withstand the severe winters of Michigan climate, while the alfalfa is very easily killed out. It is said of the alfalfa, too, that it is liable to be crowded out by June grass, sorrel, and other weeds. So far no difficulty of this nature has been noticed with the sand-lucern seedings. It is quite probable that instead of the weeds running out the alfalfa, the alfalfa has been killed during the severe winter and the weeds have simply taken its place."

In another publication[a] it is stated that the distinction between sand lucern and the other varieties (Turkestan, French, and German) is too small to be noticed by the average observer.

A variety test was made by the Wisconsin Agricultural Experiment Station in which sand lucern was compared with two other varieties of alfalfa.[b] The yields of the cured hay per acre were as follows:

	Tons.
Sand lucern	5.6
Ordinary alfalfa	5.7
Turkestan alfalfa	5.0

These plots successfully withstood the winter of 1903–4, which was noted for its severity. The plots of alfalfa were exposed to the elements without a covering of snow during a large portion of the winter. Unfortunately, it was found necessary to discontinue these tests before the results of the succeeding season could be obtained.

The Utah Agricultural Experiment Station made a comparative test under semiarid conditions between sand lucern and other varieties at the Iron County Experimental Farm, where the rainfall from April 1 to July 20, 1906, was 3.20 inches. The Turkestan alfalfa gave 620 pounds of cured hay per acre, as compared with 590 pounds for the sand lucern and 110 pounds for the Utah dry-land strain. On the Juab County Experimental Farm, where the rainfall was heavier, being 18.44 inches from August 1, 1905, to July 31, 1906, and 6.34 inches from April 1 to July 20, 1906, the Utah dry-land alfalfa gave 2,300 pounds for the Utah seed, which had been produced under irrigation, while the Turkestan gave only 1,500 pounds and the sand lucern 2,050 pounds to the acre. It was pointed out that under conditions of extreme drought the sand lucern and Turkestan alfalfas were apparently superior to the other varieties, although it is stated that definite conclusions should not be drawn from the single series of tests.[c]

Results (unpublished in part) secured at the Kansas Agricultural Experiment Station have shown the ordinary alfalfa to give a heavier yield than either the sand lucern or Turkestan alfalfa in comparison with which it was tested.[d] The normal rainfall of Manhattan, Kans., is 32 inches. The following table indicates the results per acre secured from these plots in the area devoted to small plot tests:

Variety.	Yield in 1906.	Yield in 1907.
	Pounds.	*Pounds.*
Sand lucern (variegated)	5,960	5,280
Ordinary alfalfa	7,340	5,720
Turkestan alfalfa	6.840	5.160

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[a] Seventeenth Annual Report, Michigan Agricultural Experiment Station, 1904, p. 222.

[b] Bulletin 121, Wisconsin Agricultural Experiment Station. 1905.

[c] Bulletin 100, Utah Agricultural Experiment Station. 1906.

[d] Bulletin 155, Kansas Agricultural Experiment Station, p. 256.

Aside from the apparent slight inferiority of sand lucern as to yields in sections where ordinary alfalfa is specially adapted, it is probable that under such conditions the recognized tendency of the sand lucern to lodge still further reduces the yield of hay actually received from a given area.

The tests made by the United States Department of Agriculture have indicated that in the regular alfalfa-producing sections sand lucern possesses no apparent merit over the ordinary alfalfa, which succeeds so well under the conditions present in such sections. It has, however, proved specially adapted to the semiarid sections and to the States where ordinary alfalfa is apt to winterkill. It has also shown some indications of being better adapted to the soils of the humid Eastern States, where the conditions are somewhat unfavorable to the successful production of ordinary alfalfa. The drought resistance of sand lucern is indicated in the following tabulation of yields of cured hay and seed per acre secured from three varieties of alfalfa sixteen months after seeding, grown on the uplands of western Nebraska, where the normal annual rainfall is about 15 inches. (See Pl. VII, figs. 1 and 2.) The first crop was allowed to stand for seed, which materially reduced the yield of hay which might otherwise have been secured, since two cuttings are ordinarily procured, and in fact considerable growth was made during the latter part of August and throughout September. The figures show, however, the relative behavior of the three varieties for the one cutting, as all were given the same treatment.

Variety.	Cured hay per acre.	Seed per acre.
	Pounds.	*Pounds.*
Sand lucern (variegated) (S. P. I. No. 20457)	1,359	143
Brott's dry-land alfalfa (ordinary) (S. P. I. No. 19566)	1,154	167
Turkestan alfalfa (S. P. I. No. 18751)	908	62

At Pullman, Wash., where the normal annual rainfall is 22.37 inches, a comparative test of alfalfa varieties in which sand lucern is included is under way. The yields of the two cuttings secured during the season of 1907 from plots seeded in the spring of 1905 are as follows:

	Pounds.
Sand lucern (variegated)	7,524
Ordinary alfalfa	7,089
Turkestan alfalfa (S. P. I. No. 14786)	6,066

As an instance of its hardiness and drought resistance the following table indicates the estimated yields of sand lucern secured near Almont, N. Dak., where the normal annual rainfall is about 16.5 inches. The alfalfas experienced temperatures as low as −36° and

−23° F. in the winter of 1906–7 and 1907–8, respectively.[a] The different varieties were seeded in the spring of 1906 and all made an apparently equal showing the first summer. The cooperator, Mr. John de Lang, of Almont, N. Dak., reported that during the winter of 1906–7 none of the sand lucern was killed, while one-fourth of the Turkestan and two-fifths of the Montana-grown ordinary alfalfa were winterkilled. This winterkilling is reflected in the crop of 1907, when the estimated weights of cured hay in pounds per acre were as follows:

	Pounds.
Sand lucern (variegated) (S. P. I. No. 17087)	4,000
Turkestan (S. P. I. No. 14786)	2,667
Turkestan (commercial)	2,000
Ordinary (Montana grown) (S. P. I. No. 17698)	1,600

The yields in 1908 were much nearer equal, as the plants in the thin stand of the two varieties that were partially winterkilled had made almost sufficient growth to overcome the handicaps of the former season.

In tests made at Babb, Mont., alfalfa seed from a number of different sources was sown in the spring of 1906. The following winter a local thermometer registered −43° F. on February 1, −14° F. on March 15, and −10° F. on April 27, with 14 inches of snow.[b] The snowstorms continued several times each week until May 18. Under these trying conditions both the Turkestan alfalfa and the sand lucern are reported by the cooperator, Mr. C. L. Bristol, to have gone through the winter without injury, while the other varieties under test were more or less injured. Of the rest, the stand from seed grown in northern Montana (S. P. I. No. 17698) was best. The alfalfas grown from seed from Spain (S. P. I. No. 17992) and the Argentine Republic (S. P. I. No. 12547) were badly winterkilled.

There is some evidence to show that a number of the variegated alfalfas are better suited than is ordinary alfalfa to withstand the climatic and soil conditions of the northeastern quarter of the United States. Under such conditions, with an annual rainfall of 40 inches or over, the plants are subjected to an excess of moisture. The alternate freezing and thawing of the ground in the early spring is also very injurious to the plants. In the fall of 1904 the then Office of Grass and Forage-Crop Investigations transplanted the plants in several test rows from the Arlington Experimental Farm in Virginia to the experimental grounds of the Maryland Agricultural Experiment Station at College Park, Md. The winter, combined with the late transplanting and the rather wet ground, killed all the alfalfa which had been included in the tests except the sand lucern. In a comparative test of six different lots of alfalfas seeded about September 1, 1906, at Glyndon, Md., about 40 miles north of Washington, D. C., the sand lucern showed the best stand in the following spring, although the alfalfa secured from Montana also suffered no apparent winterkilling. The Argentine alfalfa and the ordinary commercial seed, obtained presumably from southern Europe, showed from a half to two-thirds of the plants winterkilled. The Arabian alfalfa was entirely winterkilled. The absolute minimum temperature for the winter of 1906–7 at Fullerton, Md., 18 miles southeast of Glyndon, was −1° F. At the Arlington Experimental Farm a late seeding test was started on October 18, 1907, to determine the relative hardiness of sand lucern, Turkestan alfalfa, and ordinary commercial Utah-grown seed. The plants produced only the cotyledons and the first leaf before their growth was stopped by the low winter temperatures. The following spring, of the ten hills of each that had been seeded five plants of sand lucern and three plants of Turkestan alfalfa remained. None of the plants from the Utah-grown seed survived the winter. The minimum temperature recorded at Washington, D. C., for the winter of 1907–8 was 3° F.

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[a] These figures are based on an average of those recorded at Glen Ullin, N. Dak., 25 miles northwest, and Bismarck, N. Dak., 40 miles northeast, where records are available.

[b] The minimum temperature for the winter of 1907 was —43° F., according to the official thermometer of the United States Weather Bureau.

Other points of minor agronomic importance will be discussed under the heading "Comparison of different strains of variegated alfalfa and their parents."

GRIMM ALFALFA.

Grimm alfalfa, so named from its introducer, was first grown in this country in Minnesota in 1858. In 1900 it had gained considerable local importance, at which time Mr. A. B. Lyman, of Excelsior, Minn., called it to the attention of Prof. W. M. Hays, then of the Minnesota Agricultural Experiment Station, who recognized its hardiness and general value for Minnesota conditions.[a] Owing to its hardiness this alfalfa is of great value in sections where ordinary alfalfa winterkills.[b] In addition to its remarkable showing made in Minnesota it has also proved hardy in Nebraska, Montana, North Dakota, South Dakota, and Canada.[c]

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[a] Bulletin 80, Minnesota Agricultural Experiment Station, 1903; Minnesota Press Bulletin 20, 1904.

[b] See Brand, C. J., Science, n. s., vol. 28, pp. 891–892, and Westgate, J. M., Science, n. s., vol. 30, pp. 184–186.

[c] The following extract is taken from Bulletin 101 of the South Dakota Agricultural Experiment Station, 1907, by Prof. W. A. Wheeler:

> The Grimm alfalfa has been tested in many parts of the United States as well as Canada, and has shown itself to be one of the hardiest, if not the hardiest, alfalfa under trial either by the state stations or by the United States Department of Agriculture. A plat of this variety was seen by the writer at Indian Head, Saskatchewan, in the summer of 1906, which was being grown in comparison with several others. It

The only objection to Grimm alfalfa as compared with ordinary alfalfa is a slight tendency of the stems to be decumbent, thus causing some lodging when the growth is rank. (See Pl. II, figs. 2 and 3.) This tendency is less pronounced when grown in semiarid regions, where it is also very well adapted. Numerous attempts have been made to establish ordinary alfalfa in parts of Minnesota where Grimm alfalfa is most grown. These as a rule have been comparatively short lived, while the stands of Grimm alfalfa, according to all available definite testimony, have suffered no serious winterkilling in any one winter for at least thirty years, with the exception of February, 1906.[a] (See Pl. IV, figs. 1 and 2.)

In the winter of 1898–99 it is reported that all the fields of common alfalfa seeded in Carver County were winterkilled, whereas there was no loss to the fields of Grimm alfalfa, even where the fourth crop had been severely pastured the previous fall.[b] In February, 1906, however, the early thaws and subsequent formation of ice sheets destroyed parts of many of the Grimm alfalfa fields, especially where the topography of the lands was unfavorable.[c]

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had passed through two winters without winterkilling in the least and was making a very fine growth, while others under trial had, to a large extent, winterkilled. South Dakota No. 162, which is the Grimm acclimated to South Dakota conditions, ranks with the two or three best alfalfas for South Dakota.

[a] Bulletin 80, Minnesota Agricultural Experiment Station, 1903, pp. 157–158; Farm, Stock, and Home, 1905, p. 65; Annual Report, Minnesota State Agricultural Society, 1903, p. 40.

[b] Annual Report, Minnesota State Agricultural Society, 1903, p. 40.

[c] The following signed statement, under date of July 19, 1908, from Mr. Henry Gerdsen, Victoria, Minn., an old neighbor of Mr. Grimm, throws some light on the early characteristics of this strain:

> A short time before the civil war broke out, about 1860, I visited Wendelin Grimm's place, which was 4 miles distant from my place. At that time he had quite a field—probably between 2 and 4 acres—of a solid stand of alfalfa, "everlasting clover," as Mr. Grimm called it.
>
> Mr. Grimm sold seed to his neighbors before 1864. He sold some seed to George B. Nelson, who shortly after went as a substitute for John Holtmeier, who was drafted at the last draft of the civil war, about April, 1865. I got my first alfalfa seed from George B. Nelson three or four years after the war.
>
> As long as I knew Mr. W. Grimm, from 1858 or 1859 on to his death in 1890, his alfalfa stands were never noticeably injured by the winter, except in the very low undrained places, where it always winterkills. The seed I got from Mr. Nelson I sowed in 1868 or 1869, and the same patch shows a good stand to-day (1908), the same being about 90 per cent of a perfect stand. As far as I have observed, the Grimm alfalfa has not noticeably increased in hardiness since its introduction into this country. The only serious winterkilling I have ever observed was in February, 1906, when many of the fields were injured, owing to very warm weather followed by rain and snow and subsequent cold, which formed ice sheets over many of the fields.

The following is an extract from a letter received from Mr. A. B. Lyman, of Excelsior, Minn., under date of October 21, 1908:

> It [Grimm alfalfa] was a perfect stand up to the spring of 1906, when it showed these bare spots which have since grown up to June-grass. Grimm alfalfa was never injured but once, and that was at this time. We had a very wet fall and lots of rain during early winter. The latter part of February it came off very warm. "Alfalfa started to grow," I have heard many so state. Then it turned very cold after a hot, rainy day and ice formed even on high places that were a little lower than the rest. Grimm alfalfa was injured where the ice stood.

The injury from ice sheets is illustrated in Plate IV, figure 1, which shows the appearance in 1909 of a field seeded in 1901, with a nearly perfect stand over the higher parts of the field, while the stand becomes successively thinner toward the lower places and is entirely destroyed on the low ground. The injury occurred as above indicated in the latter part of the winter of 1905–6. The normal rainfall of St. Paul, Minn., 25 miles northeast of the section where Grimm alfalfa has been successfully produced for more than fifty years, is 29 inches. The absolute minimum temperature since 1873 is −41° F. The average of the absolute minimum temperatures at St. Paul for the ten years from 1893 to 1902 is −23.3° F.

History.—Grimm alfalfa was brought to this country in 1857 by Mr. W. Grimm from Külzheim, a small village near Wertheim, in the province of Baden, Germany. This statement is based on the evidence of Mr. Grimm's son, Mr. Frank Grimm, of Chaska, Minn., who was 9 years of age at the time his father emigrated to this country. A further substantiation is the testimony of several neighbors of Mr. W. Grimm, who obtained their information directly from him.[a] The seed, said to be about 15 pounds, is stated to have been first sown by Mr. Grimm in 1858.

There appears to have been a good deal of discussion by the late Mr. Grimm and his neighbors as to the original source of the seed brought from Wertheim, where it had been grown for some years before Mr. Grimm came to America. As a result of this, more or less credence has been given to the view that it came originally from Norway, Sweden, or Switzerland. Apparently the reason for this belief was the need of an explanation for its hardiness, as the climate of Wertheim is by no means severe. The average of the absolute minimum temperatures at Wurzburg, 20 miles distant, for the ten years from 1893 to 1902, inclusive, is 3.7° F., whereas the average for St. Paul, Minn., for the same years is −23.3° F. It is also possible that the idea of its Swedish origin comes from the fact that sand lucern has been known as Swedish alfalfa, since it had early been raised in that country. It is easy also to confuse Norway with Sweden. This hearsay evidence is of little moment but accounts for the published statements suggesting both Norway and Switzerland as the original source of this strain.[b]

There are two possible explanations to account for the hardiness of Grimm alfalfa. One is that it was ordinary alfalfa when brought to Minnesota and that it has, since its introduction, developed hardiness by acclimatization.[a] The consensus of opinion, however, among the old neighbors of Mr. Grimm is that it was hardier than ordinary alfalfa from the start and has not noticeably increased in hardiness since its introduction.[b] The second explanation is that the hardiness is due to its possessing a small percentage of the blood of the hardy yellow-flowered alfalfa (*Medicago falcata*) of Europe and Asia.

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[a] The statement made in Minnesota Press Bulletin 20 that Bonn, Germany, was the European source of the Grimm alfalfa is apparently due to confusing Bonn with Baden.

[b] Bulletin 80, Minnesota Agricultural Experiment Station, 1903; Minnesota Press Bulletin 20, 1904; Annual Report, Minnesota State Agricultural Society, 1903, p. 40.

It is probable that the original group of dilute hybrids contained some plants which were less hardy than others. There were apparently enough hardy individuals to maintain the stands, although, as with any aging alfalfa field, the number of the individual plants became less and less as the plants grew larger. Any gradual elimination by the successive winterkilling would be compensated for by the subsequent increase in the size of the surviving plants. (See Pl. V, fig. 1.) In this way natural selection is probably always at work in sections presenting unfavorable conditions for the crop. The seed from an old field from which the less hardy plants have been gradually eliminated presumably presents better possibilities for producing hardy seed, as not only the mother plants are the hardiest of the original seeding, but the male parentage is also of the same naturally selected stock, unless there be present associated fields of a less hardy strain. There must have been, however, an initial hardiness in a considerable proportion of the early seedings to have enabled the stands to maintain themselves as they did under the severe conditions present. The effect of the Minnesota winters on ordinary alfalfa has usually been to practically ruin the stand within a few years. This is illustrated in Plate V, figure 2, the field shown with a ruined stand of ordinary alfalfa being located within a few miles of the two fields of Grimm alfalfa illustrated in Plate IV, figure 1, and in Plate V, figure 1.

The evidence of the presence of the yellow-flowered blood in the Grimm alfalfa is borne out by the habit of the individual plants, as well as by the structure of the stems, leaves, and flowers, together with the hardiness and drought resistance of the strain itself. In these respects it is different from ordinary alfalfa and agrees with the commercial sand lucern, which is apparently hardier than ordinary alfalfa by reason of the yellow-flowered alfalfa blood in its ancestry. The data tabulated on page 39 show the resemblance between commercial sand lucern and Grimm alfalfa in numerous botanical characteristics and as clearly show their similar botanical differences from ordinary alfalfa.

There are two possible explanations as to how the yellow-flowered blood became introduced into the Grimm alfalfa. One is that it is ordinary alfalfa which has been gradually influenced by wild yellow-flowered alfalfa plants growing in the vicinity of the fields. This mixing has apparently resulted in some degree wherever the ordinary alfalfa has been grown in sections where the yellow-flowered alfalfa occurs wild.

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[a] Annual Report, Minnesota State Agricultural Society, 1903, p. 40.

[b] Bulletin 80, Minnesota Agricultural Experiment Station; Farm, Stock, and Home, 1905, p. 65.

The second explanation is that the hybrid intermediate forms originally known as sand lucern have become repeatedly crossed with ordinary alfalfa, both by having been grown alongside fields of ordinary alfalfa and by having the ordinary seed mixed with that of the old sand lucern. This is presumably what has occurred to most lots of the original intermediate forms of sand lucern which have come to approach ordinary alfalfa somewhat closely in character. By whichever means the Grimm alfalfa came by its yellow-flowered ancestry, the fact remains that there is apparently about one-third as much yellow-flowered blood in the Grimm alfalfa as occurs in the lots of commercial sand lucern which have been under test and observation. However, the Grimm alfalfa has been much more rigorously tested than have any of the importations of the commercial sand lucern or other strains of variegated alfalfa, and until such tests have been made the Grimm alfalfa must necessarily be assigned first place in regard to tested hardiness in Minnesota and the other States where rigorous tests have been made. As a further instance of the hardiness of the Grimm alfalfa it may be stated that in 1901 Mr. C. B. Clarke seeded Grimm, Turkestan, and ordinary alfalfa on his farm near Jamestown, N. Dak. The ordinary alfalfa was so badly winterkilled that it was plowed up. The Turkestan alfalfa was somewhat injured, but it was mown for hay for several years before it was plowed up. The Grimm alfalfa was practically uninjured.

The comparative trials of the principal strains of variegated alfalfa and ordinary alfalfa made during the winter of 1908–9 show the Grimm alfalfa to be the hardiest of all lots under test. While the sand lucern is somewhat less hardy it is much hardier than ordinary alfalfa and apparently contains a considerable proportion of plants which are well adapted to severe winter conditions.

CANADIAN ALFALFA.

The excellent showing as regards hardiness and yield made by certain of the lots of seed procured from Canadian sources and used in the extension and investigational work of the Bureau of Plant Industry[a] led to an examination of the fields from which the commercial seed is secured. It was noted in the sections visited that there were certain fields which differed markedly from the near-by fields of ordinary alfalfa and which upon examination showed the same flower-color variation and other differences from ordinary alfalfa, as in the case of the commercial sand lucern and Grimm alfalfa. One field, in fact, showed a greater percentage of plants with flower colors of the ordinary violet than has been observed in any of the other fields of hardy alfalfa noted. Unfortunately, it is the practice to bulk the seed from these fields which show the variegated flowers with the seed from the fields of the nonvariegated and presumably ordinary alfalfa. In this way its identity is largely lost and a great dilution of the yellow-flowered ancestor therefore occurs in the progeny. According to local testimony, the seed was secured through French seed houses, but no recognition of its differences from ordinary alfalfa had been noted by those growing it in Canada. The French seed houses handle the commercial sand lucern under the name of "Lucerne rustique,"[a] or hardy alfalfa, and the importations from them may have included one or more consignments of this variety. The same possibilities exist in regard to its European history as were suggested for Grimm alfalfa. Fields said to be 15 years old and still showing a good stand were noted in the vicinity of Silverdale and Welland, Ontario. The principal injury that had occurred to the stands was in fields with low places where the early thaws in February, 1906, resulted in serious damage in such places. (See Pl. IV, fig. 2.) This injury to some of the stands is probably strictly comparable with the similar injury the same winter to the Grimm alfalfa fields in Minnesota. The absolute minimum temperature for the ten years from 1893 to 1902, inclusive, of Welland, Ontario, is −19° F. The average of the annual absolute minimum temperatures for the same period is −10.7° F. The normal annual precipitation is approximately 37 inches.

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[a] S. P. I. Nos. 13436, 18629, and 19896.

At Walhalla, N. Dak., in the extreme northern part of the State, the Canadian alfalfa was reported by Mr. C. W. Andrews of that place as surviving the winter of 1906–7 better than the sand lucern or Montana-grown alfalfa.[b] The absolute minimum temperature of Pembina, N. Dak. (30 miles east of Walhalla), for the winter of 1906–7 was −43° F. The normal rainfall is 19.77 inches.

The Canadian alfalfa in the field tests at the Dickinson substation in North Dakota did not prove to be as hardy during the winter of 1908–9 as did the Grimm alfalfa, the sand lucern, or the Turkestan alfalfas. The absolute minimum temperature was −31° F., with practically no snow on the ground.

MISCELLANEOUS LOTS OF VARIEGATED ALFALFA.

In addition to the three recognized commercial strains of alfalfa which have assumed sufficient importance to have received trade names there have also appeared other lots which have not been available in sufficient quantities or have been recognized too recently to render extensive tests possible as yet. These alfalfas agree in showing the variegated flowers and as far as they have been tested show themselves to be hardier than the strains of ordinary alfalfa from corresponding sections. The source from which the various lots of seed have been obtained, as a general rule, affords a suggestion as to the probabilities of the hardiness of these strains. Tests are under way to determine the comparative hardiness of these miscellaneous lots.

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[a] The term "rustique," as here used, is the equivalent of "native" in English.

[b] Canadian alfalfa, S. P. I. No. 13436; sand lucern, S. P. I. No. 17087; Montana-grown ordinary alfalfa, S. P. I. No. 17698.

German alfalfas.—Several lots of alfalfa received from various places in Germany have proved to possess variegated flowers, and preliminary comparative studies indicate other features in common with the variegated alfalfa. All the lots secured from Germany by the Office of Forage-Crop Investigations of the Bureau of Plant Industry have shown the variegated flowers. The introductions made by private individuals and state agricultural experiment stations have not been critically examined, but considerable positive evidence for and no evidence against the relative agronomic superiority of these introductions has come to hand.[a] Among the introductions made by the Bureau of Plant Industry may be mentioned one from the Pfalz region of southern Germany, one from the province of Baden called "Old German" or "Old Frankish blue lucern," and a third from the Grand Duchy of Hesse called the "Eifeler lucern."

Pfalz adjoins the province of Baden, the original source of the Grimm alfalfa. The alfalfa from this region closely resembles both the Grimm alfalfa and the commercial sand lucern in the color of its flowers and its slight tendency to a decumbent growth. No severe test to demonstrate its relative hardiness has as yet been made. Aside from the studies indicated in the tabulations given under the heading "Botanical characteristics," no critical study of this strain has been made. It was secured under S. P. I. No. 13520.

The Eifeler lucern secured from the Grand Duchy of Hesse, Germany, under S. P. I. No. 12748, is interesting from the fact that the "heights of Eifel," located about 200 miles from where this lot was secured, are reported to have been the place where the original sand lucern plants were secured. The botanical characteristics of this strain of variegated alfalfa are indicated in the tabulations just referred to.

The Old German or Old Frankish blue lucern was secured under S. P. I. No. 22467 [b] from Oberschüpf, in the province of Baden, Germany, and less than 20 miles from the source of the Grimm alfalfa. This appears to be very similar botanically to the Grimm variety as well as to the alfalfa just described from the Pfalz region. The statements by the German Royal Agricultural Society regarding its hardiness and longevity indicate its abilities in this respect.[a]

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[a] Report, Michigan Board of Agriculture, 1907, pp. 361, 364.

[b] See "Seeds and Plants Imported during the Period from January 1 to March 31, 1908," Bulletin 137, Bureau of Plant Industry, U. S. Dept. of Agriculture.

Russian forms of variegated alfalfa from Simbirsk and Kharkof.—The alfalfas secured from Simbirsk and Kharkof have also proved to possess the variegated flowers and some of the other characteristics of variegated alfalfa. The lots secured from Simbirsk, Russia, are represented under S. P. I. Nos. 13857 and 14496. The two lots of seed from Kharkof, Russia, are represented by S. P. I. Nos. 13858 and 14497. Simbirsk is in latitude 54° 18′ north and longitude 48° 24′ east. The normal rainfall for Simbirsk is 16.3 inches, and the normal absolute annual minimum temperature based on an eleven-year average is −28° F. Kharkof is in latitude 50° north and longitude 36° 12′ east. The normal rainfall is 19.8 inches, and the normal absolute annual minimum temperature based on a nine-year average is −28° F. None of the four lots of seed secured have been extensively tested for hardiness. However, the high latitude, combined with the continental climate with its severe winters, indicates that these alfalfas must necessarily have withstood rather severe climatic conditions. It is also significant, in view of the probable explanation as to the presence of the variegated flowers, to note that *Medicago falcata* has been secured from Kharkof.[b]

Asiatic forms of variegated alfalfa.—The two lots of alfalfa secured from the northern limits of alfalfa-hay production in central Asia have proved to possess a considerable proportion of flowers with other than the ordinary violet color. The most northern lot of Turkestan alfalfa secured by Prof. N. E. Hansen in 1897 is one of these lots just mentioned. It was assigned S. P. I. No. 1151. This particular lot of alfalfa was secured from Kopal, Siberia,[c] and has proved the best of any of the numerous importations of Turkestan alfalfa tested by the California Agricultural Experiment Station. No yields for an entire season are available, but 9,256 pounds of cured hay were secured in 1908 from two of the four cuttings made at Tulare, Cal., by the California station. It was estimated that a total yield of 8½ tons for the season was secured. The second lot (S. P. I. No. 1159) secured from Kuldja, Chinese Turkestan,[a] about 130 miles southeast from the source of S. P. I. No. 1151, also produces variegated flowers and shows other botanical characteristics of the variegated alfalfa. Neither of these alfalfas has as yet been thoroughly tested for hardiness in this country, but the high latitude, together with the continental climate of the sections from which they were procured, leaves little question as to their hardiness. The normal rainfall based on a three-year average of Kopal, Siberia, is 12 inches. The average of the absolute annual minimum temperatures for ten years is −20° F.

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[a] Mitteilungen der Deutschen Landwirtschafts-Gesellschaft, part 4, 1908. A free translation is as follows:

> The Old Frankish blue lucern deserves special attention, since it is a lucern that has been cultivated for a long time in south Germany on calcareous soil and grows for a long time without reseeding. Though the qualities of the seed as to size and color, and sometimes, unfortunately, as to germination, are not so good as those of foreign origin and the price is relatively higher, yet this German lucern seems to have a considerable value, for there is an increasing number of complaints that the foreign lucerns do not last long enough without reseeding and that they suffer a great deal, especially in severe winters.

[b] S. P. I. No. 20717. See "Seeds and Plants Imported during the Period from July, 1906, to December 31, 1907," Bulletin 132, Bureau of Plant Industry, U. S. Dept. of Agriculture.

[c] Latitude 45° north, longitude 79° east.

Wheeler alfalfa.—This name is tentatively assigned to a field of 30 acres of variegated alfalfa at Bridgeport, Kans. This particular field was seeded in 1891, and although it has passed through severe winters and has been overflowed at least twice it still shows a perfect stand. The percentage of flowers other than the ordinary violet is less than in most of the other strains here designated as variegated alfalfa. This alfalfa has shown itself to be an especially strong-seeding strain, although in a section too moist for seed crops of ordinary alfalfa except in seasons of light rainfall. This particular field has produced a seed crop during each of the five years ending in 1909. It is rather more upright than the other strains of variegated alfalfa and apparently possesses considerably less of the *Medicago falcata* parentage. Tests during the winter of 1908-9 in the North-Central States show this strain to be somewhat hardier than the Provence alfalfa or the ordinary western-grown seed procured from Colorado and Utah, but it is much less hardy than the other variegated alfalfas and even than the Turkestan alfalfa and the alfalfa from northern Montana. It has proved much superior to the Provence alfalfa from France in the tests made on Long Island.

Baltic alfalfa.—This alfalfa has been so named from the fact that the seed was originally procured from Baltic or Hartford, S. Dak. It was grown for ten years near Renner, S. Dak., with marked success, and thus attracted the attention of Prof. W. A. Wheeler, who was at that time connected with the South Dakota Agricultural Experiment Station. The South Dakota station secured seed from this field for further test and extension and assigned "S. Dak. No. 167" to this strain. It has, according to the published results, proved to be very hardy and drought resistant under the severe conditions obtaining at Highmore, S. Dak., where the tests have been conducted.[a]

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[a] Latitude 44° north, longitude 81° east.

The normal annual rainfall for Highmore is 17.40 inches. The absolute minimum temperatures for 1905, 1906, and 1907 were −36°, −31°, and −27° F., respectively. This strain has proved to give relatively heavy yields of seed. The percentage of blue flowers shown in the tabulation of the flower-color counts is noteworthy.

RE-CREATION OF VARIEGATED ALFALFA.

It appears to be well established in European literature that the intermediate forms of alfalfa, as represented by the original sand lucern, were produced by natural hybridizing between *Medicago falcata*.[b]

In order to verify the statements regarding the natural hybridizing of *Medicago sativa* and *Medicago falcata* and to further determine the effect of growing the intermediate forms associated with the parental forms, experiments along this line were inaugurated in 1907. The real problem was to determine whether or not the intermediate forms approach closer and closer to the ordinary alfalfa as successive generations are grown associated with it. *Medicago falcata* was grown alongside of the ordinary alfalfa and the seed gathered in the autumn. The resulting plants were hybrids, some of which showed a relatively close resemblance to *Medicago falcata*, while others resembled ordinary alfalfa more closely than they did the falcate-podded female parent. One of the plants was as erect as ordinary alfalfa and showed the normal violet color in the flower.

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[a] Wheeler, W. A. Bulletin 101, South Dakota Agricultural Experiment Station. 1907:

A two years' trial of the variety is rather short upon which to draw conclusions. In all our tests, however, both at Highmore and Brookings, this number has shown itself equal to any in quality, hardiness, and seed production. It has not been sown in the selection rows and so has not been put to quite so severe a test for hardiness as No. 162 [Grimm alfalfa], and as there is no record of its having been tested under northern conditions in the past, as has No. 162, it can not be compared in hardiness to the latter number. In seed production it is equal if not superior to No. 162. In quality and the vigor of early spring growth it appears to be equal to any.

[b] Urban, I. Verhandlungen des Botanischen Vereins der Provinz Brandenburg. 1877, vol. 19, p. 125. Urban's experiments showed that when the yellow-flowered alfalfa is grown alongside of the ordinary alfalfa reciprocal hybrids are produced. The hybrid progeny of the crossing of *Medicago falcata* and *Medicago sativa* could not be distinguished from the reciprocal hybrids. The reciprocal prepotency of the pollen of one species over that of the other is indicated by the fact that all of the plants produced from seed gathered from the yellow-flowered plants produced hybrids, while but two of the plants from seed gathered from the ordinary alfalfa failed to show the same intermediate characters of semiprostrateness and flower-color variation.

(See Pl. III, fig. 1.) The fact that the pods of the last-named plant showed but from three-fourths to one turn was the principal indication that the hybrid gave of its yellow-flowered falcate-podded ancestry. (See fig. 1, *B*.)

This hybrid plant in turn was permitted to set seed in association with ordinary alfalfa. The progeny resembled ordinary alfalfa more closely than did the first-generation hybrid, which was its female parent. (See fig. 1, *C*.) The coil of the pods had increased from three-fourths of a turn to one and one-half turns. Another plant showing intermediate characters, including pods with one and one-half turns, was allowed to set seed in association with ordinary alfalfa. With one exception, the progeny showed marked approaches toward ordinary alfalfa. (See fig. 1, *E*.) In fact, herbarium material could with difficulty be distinguished from *Medicago sativa* except for the presence of the variegated flowers, passing successively from purple through blue to some shade of yellow.

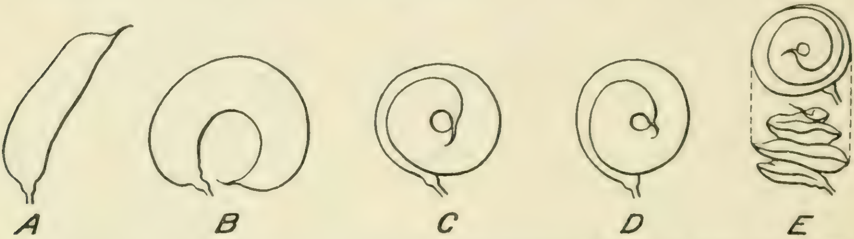

FIG. 1.—Pods of various alfalfas from plants grown near ordinary alfalfa and presumably crossed with it: *A*, *Medicago falcata;* *B*, progeny of plant of *Medicago falcata* shown in *A;* *C*, progeny of plant of *Medicago falcata* shown in *B;* *D*, intermediate alfalfa; *E*, progeny of intermediate alfalfa shown in *D*.

In other experiments performed at the Arlington Experimental Farm open-fertilized violet-flowered plants of the variegated strain of alfalfa have produced progeny showing a much less tendency to vary from the mother plant in flower color than do the plants bearing flowers showing some trace of yellow.

Inbred seed of variegated alfalfa plants with flowers of whatever color normally comes much truer to type than does the open-fertilized seed from the same plants. The experiments indicate that alfalfa is normally open-fertilized and that there is a decided tendency on the part of the intermediate forms to break up, especially when open-fertilized. The descendants of *Medicago falcata* when grown in association with ordinary alfalfa approach closer and closer to ordinary alfalfa at each successive generation. Only a few generations are necessary to produce a stock of plants the majority of which are indistinguishable in appearance from those bearing the variegated flowers to be noted in the various strains of variegated alfalfa. This affords a logical explanation of the observed fact that the sand lucern of the present day has come to be quite different in appearance and habit from the original forms upon which are based most of the European accounts, both in agronomic and botanical literature. The result has apparently been the same where fields of ordinary alfalfa have been gradually influenced by the neighboring wild plants of *Medicago falcata* or by fields or chance plants of hybrid forms.

In other experiments performed at the Arlington Experimental Farm the prepotency of *Medicago falcata* over the pollen of *Medicago sativa* on open-fertilized plants has not been demonstrated. The progeny of ordinary alfalfa grown associated with *Medicago falcata* has not shown any indication of *Medicago falcata* parentage. However, the associated yellow-flowered plants were very few in number at the time, so that the chances of the pollen from the yellow-flowered species reaching the stigmas of the ordinary alfalfa flowers were relatively small. It should be noted also that examination has shown that the flowers of *Medicago falcata* at the Arlington Experimental Farm produce but a meager supply of pollen as compared with the associated flowers of *Medicago sativa.*

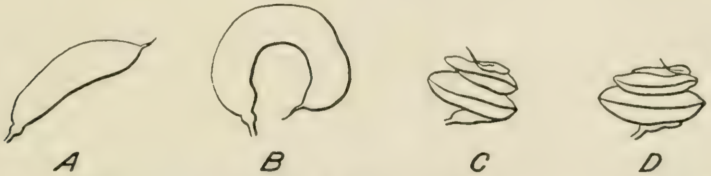

FIG. 2.—Pods of artificial hybrid and parents: *A*, *Medicago falcata*, male parent of plant shown in *B*; *B*, artificial hybrid between the plants shown in *A* and *C*; *C*, *Medicago sativa*, female parent of plant shown in *B*; *D*, pod from inbred seed from female parent of plant shown in *B*.

Artificial hybrids were secured, however, by tripping *Medicago sativa* flowers on the stamen masses of a freshly tripped *Medicago falcata* flower. (See fig. 2.) Since the anthers had not been removed from the flowers of the ordinary alfalfa, it is reasonable to assume that the flowers' own pollen was present, but that it was ineffective in the presence of the pollen from *Medicago falcata.*[a]

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[a] These results are confirmed by letters received from Dr. I. Urban, Under-Director of the Royal Botanical Gardens and Museums, Berlin, Germany, under date of September 23, 1908, in part as follows:

> My firm conviction is that sand lucern originally resulted from the intercrossing of *Medicago falcata* and *M. sativa.* The sand lucern now on the market is the product of the crossing of these hybrid plants among themselves and perhaps sometimes with the true lucern. The greater tendency to "lie down" and the greater power of resistance to drought are due to the influence of *M. falcata.*

A free translation of a letter dated August 1, 1908, from Dr. F. G. Stebler, Director of the Seed Control Station, Zürich, Switzerland, is in part as follows:

> That the commercial sand lucern has so many violet-flowered and upright forms is due to the fact that with the sand lucern, as well as with the sickle lucern (*Medicago falcata*), cross-pollination is preferred. Pollen of the common lucern is more effective than its own pollen.

COMPARISON OF DIFFERENT STRAINS OF VARIEGATED ALFALFA AND THEIR PARENTS.

A comparative study of the botanical and physiological characters of variegated alfalfa indicates their close relationship and reveals the characters which point to their hybrid origin. The lack of sufficient material has prevented a complete comparative study being made of some of the less well-known strains, but such studies as have been possible indicate rather close relationships.

BOTANICAL CHARACTERISTICS.

In connection with studies as to the botanical characteristics of the different strains of variegated alfalfa observations have been made as to the color of the flowers, size of the floral parts, weight of the seeds, leaf characteristics, and abnormal inflorescences.

VARIATION IN FLOWER COLOR.

Probably the most striking characteristic of the hardy alfalfas is that from 10 to 70 per cent of the plants bear flowers of some other color than violet, among them being blue, dark purple, green, and yellow. These colors are often slightly masked by smoky hues, which increase as the flower becomes older. In addition to this, another phenomenon is that the flowers themselves often show a progressive change in color as they grow older. The buds are almost invariably purple. Some of the flowers will at first be violet, then blue, then bluish green, shading into yellow as the flower becomes aged. In some cases the yellow stage is reached while the flowers are still in their prime; in others the progressive changes may advance no farther than the blue or green, while in still others the ordinary violet may remain dominant throughout the life of the flower.[a]

A possible explanation of this phenomena is that the yellow is present in the flower, but is usually masked by the other colors, which, however, are not so permanent, and as these gradually fade the yellow becomes apparent. Table I shows the results of counts of the flower color of consecutive plants in numerous plots and fields of the different strains of hardy or variegated alfalfa to determine the relative percentages of plants bearing flowers of the principal color types.[a]

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[a] In this connection it seems worthy of note that a number of European floras describe this succession of the floral color in the intermediate forms of alfalfa as being in the reverse order from what has been noted by the author in the living specimens examined. As an instance, it may be cited that in discussing sand lucern, which he recognizes as a hybrid between *Medicago falcata* and *Medicago sativa*, Koch states: "Bluten *farbenwechselnd*, zuerst gelb, dann grasgrün, zuletzt bläulich oder violett." (Synopsis der Deutschen und Schweizer Flora, 3d ed., 1892, vol. 1, p. 537.)

It has been necessary to arrange the color variation into fourteen groups, although nearly fifty different colors or different variations in the colors and rapidity of transition from one color to others in the series have been noted.[b]

TABLE I.—*Results of counts of the various colors found on the flowers of plants of different varieties or strains of variegated and other alfalfas.**

Color of flower.	Medicago falcata.	Unmixed hybrids—M. falcata×M. sativa.	Grimm alfalfa.	Sand lucern.	Canadian alfalfa.	Baltic alfalfa.	Pfalz (German) alfalfa.	Kharkof (Russian) alfalfa.	Simbirsk (Russian) alfalfa.	Wheeler (Kansas) alfalfa.	Algerian (hardy form) alfalfa.	Chinese alfalfa.	Ordinary alfalfa.	Provence Turkestan alfalfa.	Italian Turkestan alfalfa.	Ordinary western-grown alfalfa.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
Ordinary violet and lavender	0	6	194	307	314	20	17	43	45	228	8	27	223	108	19	814
Violet, lavender (rarely blue), with dark keels	0	3	47	84	109	10	0	13	6	8	0	6	6	3	0	29
Dark purple	0	0	52	60	62	4	8	10	10	20	3	3	9	6	2	23
Very light lavender	0	0	45	52	28	7	0	8	7	15	1	2	4	0	0	12
Bluish (usually rusty when old)	0	14	179	137	213	27	9	41	9	30	5	8	4	18	4	30
White, tinged with blue or lavender	0	0	4	1	2	2	1	3	2	0	0	0	0	0	0	0
White (ivory)	0	7	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Wine color	0	1	6	16	1	2	0	5	3	10	3	2	3	0	0	0
Reddish lavender	0	6	1	11	3	3	9	3	1	0	0	2	0	0	0	0
Blue-black	0	0	5	3	9	0	2	1	3	1	0	0	0	1	0	0
Blue-green passing into yellow-green	0	6	10	10	4	9	1	6	2	0	0	2	0	0	0	0
Blue or violet, with yellow keels	0	4	13	20	1	3	0	6	3	3	0	1	0	1	0	0
Old flowers cream or yellow	0	38	25	31	15	3	2	11	1	6	2	4	0	1	0	0
Yellow or cream	100	2	1	4	2	0	0	0	0	0	0	2	0	0	0	0
Total number of plants counted.	100	87	583	737	764	90	49	150	92	321	22	59	249	138	25	908

*The color of the prime flowers is specified except as noted.

[a] In connection with the explanation advanced for the presence of blue and other colored flowers in hardy alfalfa it may be stated that several introductions of ordinary alfalfa, especially from France and Italy, have shown the presence of some flower-color variation, especially as regards the presence of blue flowers. This is noted in the tabulations here presented. It is not illogical to attribute this phenomenon to the effect of the pollen of scattered wild plants of *Medicago falcata*, which also occur in southern Europe. Any ordinary alfalfa which at any time in its history has been associated with plants of *Medicago falcata* may be expected to show at least slight traces of the mixed ancestry. With no opportunity for elimination of any nonhardy forms that might arise it is hardly probable that such strains would be as hardy as those grown under more severe conditions. In this connection it may be noted that one introduction from Algeria (S. P. I. No. 12803) has shown variegated flowers, as indicated in the tabulation of flower-color variations. This has proved much hardier than the nonvariegated alfalfas from the same section, but has shown some winterkilling under severe tests. The plants from which the seed was secured were said to be much more drought resistant than the ordinary alfalfa.

[b] In making the counts 100 consecutive plants were counted wherever possible. The starting point was taken at random, the usual method being to count consecutive plants in a row, or to count the plants in a rectangle whose center was selected at random, usually by casting some object backward over the head into the field to be examined. One side of the rectangle was extended until the required number of plants had been counted.

The results of the counts of even as many as 100 consecutive plants usually show considerable variation in different fields of the same strain or even in different parts of the same field.

TABLE I.—*Results of counts of the various colors found on the flowers of plants of different varieties or strains of variegated and other alfalfas*—Continued.

APPROXIMATE PERCENTAGES.

Color of flower.	Medicago falcata.	Unmixed hybrids—M. falcata×M. sativa.	Grimm alfalfa.	Sand lucern.	Canadian alfalfa.	Baltic alfalfa.	Pfalz (German) alfalfa.	Kharkof (Russian) alfalfa.	Simbirsk (Russian) alfalfa.	Wheeler (Kansas) alfalfa.	Algerian (hardy form) alfalfa.	Chinese alfalfa.	Ordinary alfalfa.	Provence Turkestan alfalfa.	Italian Turkestan alfalfa.	Ordinary western-grown alfalfa.
	P.ct	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*	*P.ct*
Ordinary violet and lavender	0	6.9	33.3	41.7	41.1	22.2	34.7	28.7	48.9	71.0	36.4	45.7	89.6	78.3	76.0	89.7
Violet, lavender (rarely blue), with dark keels	0	3.4	8.1	11.4	14.3	11.1	0.0	8.7	6.4	2.5	0.0	10.2	2.4	2.2	0.0	3.2
Dark purple	0	0.0	8.9	8.1	8.0	4.5	16.3	6.7	10.9	6.2	13.6	5.1	3.6	4.4	8.0	2.5
Very light lavender	0	0.0	7.7	7.1	3.6	7.8	0.0	5.3	7.5	4.7	4.5	3.4	1.6	0.0	0.0	1.3
Bluish (usually rusty when old)	0	16.1	30.7	18.6	27.9	30.0	18.4	27.3	9.8	9.3	22.8	13.5	1.6	13.0	16.0	3.3
White, tinged with blue or lavender	0	0.0	0.7	0.1	0.3	2.2	2.0	2.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White (ivory)	0	8.1	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wine color	0	1.2	1.0	2.2	0.1	2.2	0.0	3.3	3.3	3.1	13.6	3.4	1.2	0.0	0.0	0.0
Reddish lavender	0	6.9	0.2	1.5	0.4	3.3	18.4	2.0	1.1	0.0	0.0	3.4	0.0	0.0	0.0	0.0
Blue-black	0	0.0	0.8	0.4	1.2	0.0	4.1	0.7	3.3	0.3	0.0	0.0	0.0	0.7	0.0	0.0
Blue-green passing into yellow-green	0	6.9	1.7	1.4	0.5	10.0	2.0	4.0	2.2	0.0	0.0	3.4	0.0	0.0	0.0	0.0
Blue or violet, with yellow keels	0	4.6	2.2	2.7	0.1	3.3	0.0	4.0	3.3	0.9	0.0	1.7	0.0	0.7	0.0	0.0
Old flowers cream or yellow	0	43.6	4.3	4.2	2.0	3.3	4.0	7.3	1.1	2.0	9.1	6.8	0.0	0.7	0.0	0.0
Yellow or cream	100	2.3	0.2	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0

MEASUREMENTS OF FLORAL PARTS OF VARIEGATED ALFALFA.

In order to determine to what extent the floral parts of the different strains of hardy alfalfa are intermediate between the two parents (see fig. 3) a number of measurements were made, the summaries of which are presented in Table II. Thirty plants of each of the three strains of hardy alfalfa under special study were selected. Five plants each of the six most characteristic colors were included in the selections made from each of the three strains.

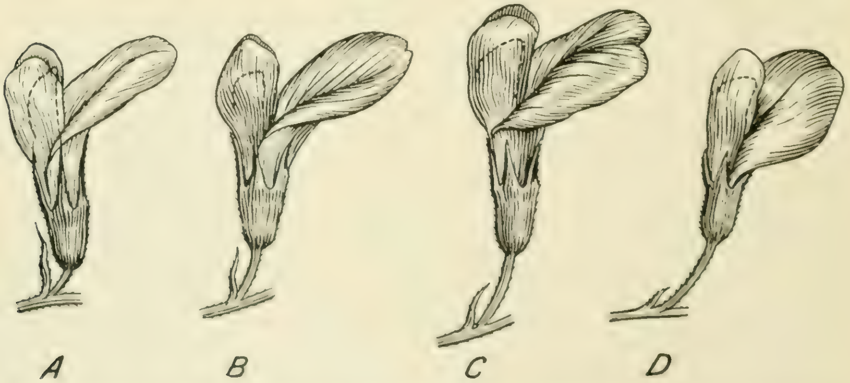

FIG. 3.—Flowers of variegated alfalfa and parental species: *A*, *Medicago sativa;* *B*, Grimm alfalfa; *C*, intermediate form; *D*, *Medicago falcata.*

Three flowers on each plant were measured. The color types included were ordinary violet, dark purple, blue, very light lavender, and yellow or green. In addition, there was included a series of flowers which showed some shade of yellow appearing in the old flowers. As a basis of comparison, measurements were made of thirty plants of ordinary western-grown alfalfa, six plants of the yellow-flowered falcate-podded alfalfa, and thirteen plants of what are regarded as strictly intermediate forms between the two parents and comparable with the original form of sand lucern.

TABLE II.—*Results of measurements of the floral parts of several varieties or strains of variegated and other alfalfas.*

Variety or strain.	Length of floral bract.	Length of pedicel.	Length of calyx tube.	Length of calyx teeth.	Length of flower.	Width of standard.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Ordinary western-grown alfalfa	1.5	1.4	2.42	3.23	9.9	4.42
Commercial sand lucern (variegated)	1.8	1.7	2.40	3.0	9.2	4.3
Grimm alfalfa (variegated)	1.7	1.6	2.3	3.18	9.4	4.3
Canadian alfalfa (variegated)	1.8	1.6	2.41	3.0	9.2	4.35
Old intermediate form of sand lucern	1.6	2.2	2.21	2.7	9.5	5.0
Yellow-flowered falcate-podded alfalfa	1.9	2.8	2.22	2.6	8.9	4.7

POD CHARACTERS OF VARIEGATED ALFALFA.

With the exception of the striking difference in flower color the shape of the pods of the two parent species is the most distinctive character. In the intermediate forms the pods are usually coiled from one to two times in rather loose spirals. In this way they resemble the falcate-podded parent on the one hand and the ordinary alfalfa with its pods tightly coiled several times on the other. In all of the variegated alfalfas examined there have been found pods more loosely coiled than are the pods of ordinary alfalfa. The predominating pods, however, are indistinguishable from those of the ordinary variety. Occasional plants, however, are to be observed showing pods with one to one and a half coils of the spiral. (See fig. 4.)

SIZE OF SEED OF VARIEGATED ALFALFA.

The number of seeds per pound, calculated from the actual weights of 100 or more seeds, is given in Table III. The samples were taken at random and the seeds counted off consecutively. All the lots were not uniformly cleaned. In some lots all the light seeds were blown over in the fanning mill. The seeds of the variegated alfalfas are more uneven in size than are the seeds of ordinary alfalfa, and it often happens in cleaning that the small seeds are sifted out with weed seeds of about the same size. These sources of error make the results not strictly comparable, but they indicate the tendencies on the part of the different strains of alfalfa.

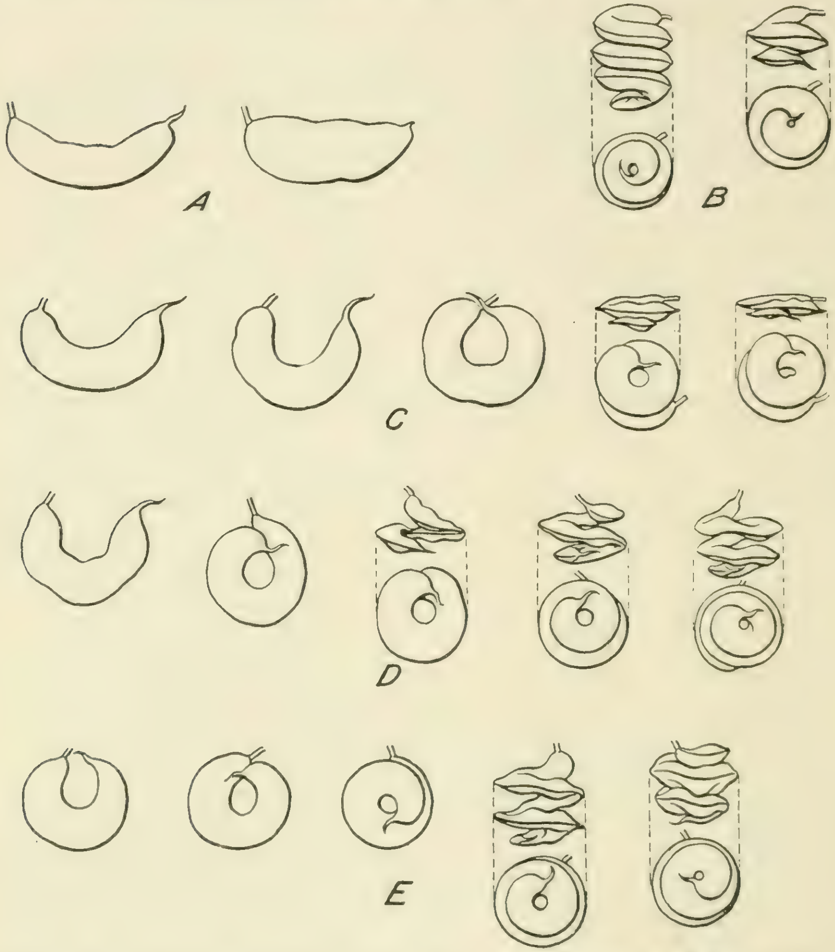

Fig. 4.—Pods of variegated alfalfa and parental species: *A*, *Medicago falcata;* *B*, *Medicago sativa;* *C*, intermediate forms of alfalfa; *D*, commercial sand lucern; *E*, Grimm alfalfa. The pods coiled less than once are uncommon in commercial sand lucern and rare in Grimm alfalfa, although the intermediate forms often show them. The fourth and fifth figures in *D* and *E* represent the predominant types in both the commercial sand lucern and the Grimm alfalfa.

TABLE III.—*Number of seeds to the pound in various samples of variegated and other alfalfas, with origin of the samples of which counts were made.*

S. P. I. numbers assigned to lots of seed.	Variety or strain and origin of seed.	Seeds to the pound.
		Number.
20719	Medicago falcata from Omsk, Siberia	342,383
20726	Medicago falcata from Samara, Russia (near Siberia)	426,491
20571	Intermediate forms from Upsala, Sweden	272,673
16399	Sand lucern from Pullman, Wash. (grown alongside ordinary alfalfa)	222,767
21217	Sand lucern (variegated) from Europe	248,631
21269	do	250,138
21938	Grimm alfalfa (variegated) from Excelsior, Minn	242,521
21827	Grimm alfalfa (variegated) from Montana	222,568
22467	Old German Frankish lucern (variegated) from Germany	255,487
21247	Canadian alfalfa (variegated) from Ontario	241,489
14497	Russian alfalfa (variegated) from Kharkof	231,515
13857	Russian alfalfa (variegated) from Simbirsk	229,932
12748	Eifeler lucern (variegated) from Germany	232,463
9359	Turkestan alfalfa from Caucasia	228,198
18751	Turkestan alfalfa (commercial)	228,733
12695	Ordinary alfalfa from France (Provence)	214,201
13481	Ordinary alfalfa from Italy	220,068
12549	Ordinary alfalfa from Argentina	174,810
11652	Ordinary alfalfa from Mexico	234,172
23454	Ordinary alfalfa from Montana	244,393

SUMMARY.	Number of seeds to the pound.
Medicago falcata	384,437
Intermediate alfalfa	272,673
Variegated alfalfas	237,751
Turkestan alfalfas	228,466
Ordinary alfalfas	217,529

LEAF CHARACTERS OF VARIEGATED ALFALFA.

Outline of leaves.—The size and shape of the leaves of both parents, as well as the hybrid forms, vary so much among themselves that no hard and fast description can be made. As a rule, however, the variegated alfalfa shows many of its leaves deeply notched or mucronate at the apex, as is commonly to be observed in *Medicago falcata*. The leaves of ordinary alfalfa are commonly taper pointed and dentate toward the apex, although leaves deeply notched or with mucronate apices are rather frequently noted. This character is of value principally in connection with other characters, as taken in itself it is not conclusive.

Supernumerary leaflets.—A more noticeable characteristic is the presence of supernumerary leaflets on the leaves of many plants of variegated alfalfa. (See fig. 5.) This phenomenon is rather rarely to be observed in ordinary alfalfa, but is very common in the yellow-flowered alfalfas. The occurrence of supernumerary leaflets is more frequently to be observed when the plants are grown isolated and under conditions which tend to produce rapid growth. Table IV, regarding alfalfa grown in rows at the Arlington Experimental Farm, near Washington, D. C., shows that 8 per cent of the plants of ordinary alfalfa occasionally produce supernumerary leaflets, while of the yellow-flowered alfalfas 50 per cent bear such leaflets. The average for the variegated alfalfas was 26 per cent.[a]

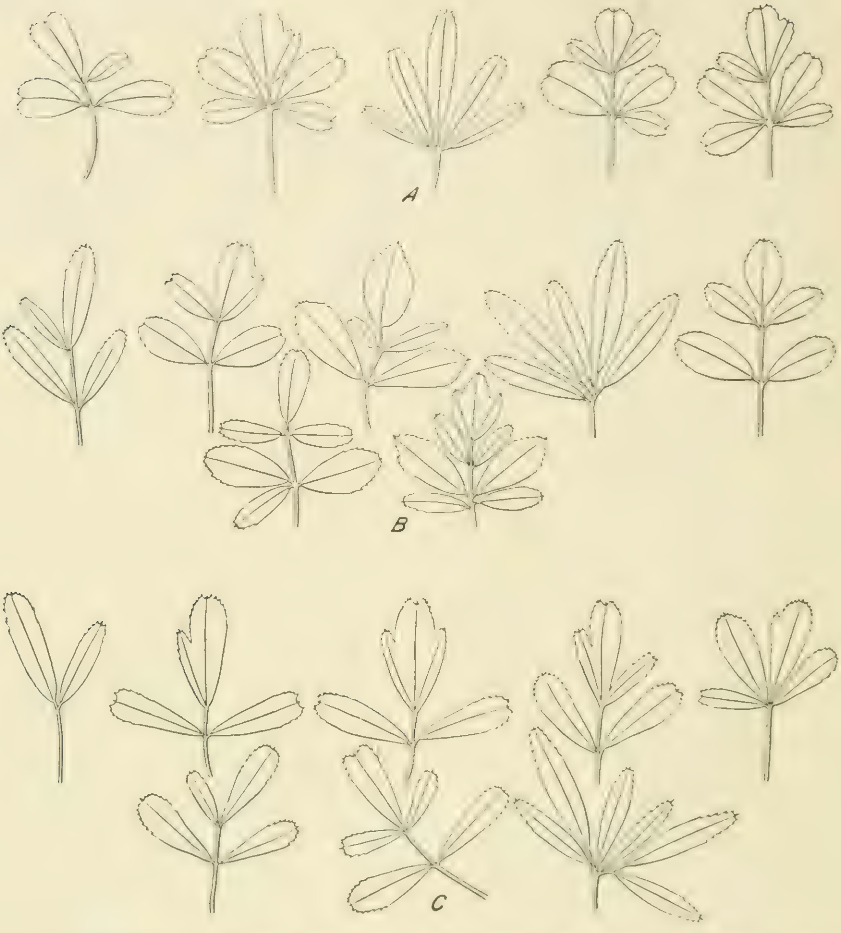

FIG. 5.—Supernumerary leaflets: *A*, *Medicago falcata* (central figure), with two leaves from the intermediate forms on either side; *B*, Grimm alfalfa; *C*, commercial sand lucern.

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[a] These counts were, with two exceptions, made on the first crop of the second season's growth of spring-seeded alfalfas in rows 39 inches apart, with the plants rather thin in the row. The Wheeler alfalfa was present at the testing station only in the form of 10 selections from which rooted cuttings had been made. The plants of Old Frankish blue lucern (S. P. I. No. 22467) were not examined until the fall of 1908 in a row which had been seeded the preceding spring. An adjoining row of sand lucern (S. P. I. No. 22418), seeded at the same time, was examined as a basis of comparison. The 20 plants examined were found to show 2 plants possessing supernumerary leaflets.

TABLE IV.—*Supernumerary leaflets on plants of variegated and other alfalfas grown at the Arlington Experimental Farm, near Washington, D. C.*

Variety or strain.	Varieties or strains counted.	Plants examined.	Plants bearing supernumerary leaflets.	
	Number.	*Number.*	*Number.*	*Per cent.*
Yellow-flowered alfalfa	4	18	9	50
Ordinary alfalfa	9	469	36	8
Intermediate alfalfa	2	29	16	55
Grimm alfalfa (variegated; plants in greenhouse)	1	8	4	50
German alfalfa (variegated), S. P. I. No. 13520	1	32	11	34
Baltic alfalfa (variegated), S. P. I. No. 19969	1	20	6	30
Oregon dry-land alfalfa (variegated)	1	4	1	25
Commercial sand lucern (variegated)	3	100	21	21
Chinese Turkestan alfalfa (variegated)	1	42	8	19
Canadian mixed commercial alfalfa (variegated)	2	97	15	15
Wheeler alfalfa (variegated)	1	10	1	10
Turkestan alfalfa	11	477	40	9
Provence alfalfa	1	39	3	8
Arabian alfalfa	3	168	10	6
Andean alfalfa (Peru and Ecuador)	4	164	3	2

Relative abundance of stomata on leaves.—In a preliminary study to determine a possible explanation of the drought resistance of variegated alfalfa it was observed that there was in specimens studied a correlation between the number of stomata per square millimeter and the ability of the plant to resist drought. Counts were also made of both ordinary alfalfa and *Medicago falcata* to determine, if possible, to what extent the character is hereditary or adaptive. Table V indicates the results of the counts of stomata occurring on the under side of the leaves in question:

TABLE V.—*Number of stomata found on the under side of the leaves of plants of variegated and other alfalfas grown at the Arlington Experimental Farm.*

Numbers assigned to plants.	Variety or strain and origin of seed.	Counts made.	Stomata per sq. mm.
		Number.	*Number.*
19534	Medicago falcata from experiment station, Valuiki, Samara Province, Russia.	16	173
20717	Medicago falcata from Kharkof, Russia	5	190
20720	Medicago falcata from Irkutsk, eastern Siberia	4	185
20721	Medicago falcata from Samara Province, Russia	3	193
20725	Medicago falcata from Moscow, Russia (originally from Don Province, in southeastern Russia).	4	185
0686H	Intermediate alfalfa (natural hybrid, Medicago falcata × M. sativa).	1	209
0686C	do	5	246
0686L	do	3	169
0686N	do	2	278
20571	Intermediate alfalfa from Upsula, Sweden	18	253
12991	Grimm alfalfa (variegated) from Alma, Nebr	8	237
16399	Sand lucern (variegated) from Pullman, Wash	1	255
22467	Old German Frankish lucern (variegated) from Germany	6	166
13521	Algerian alfalfa (variegated; relatively hardy)	5	227
Ag. 116	Dry-land alfalfa selection (variegated) from eastern Colorado	5	167
Ag. 42	Dry-land alfalfa selection (variegated) from western Kansas	3	225
Ag. 43	Dry-land alfalfa selection (variegated) from western Kansas	5	202
18827	Ordinary alfalfa, commercial, western grown	17	302
21005	Ordinary alfalfa from south-central Montana	6	286
13437	Ordinary alfalfa from Arizona, grown under irrigation	5	385
17698	Ordinary alfalfa from northern Montana	2	264
19522	Ordinary alfalfa, Provence	4	280
19566	Ordinary alfalfa from Sextorp, Nebr. (Nebraska dry-land alfalfa)	7	234

TABLE V.—*Number of stomata found on the under side of the leaves of plants of variegated and other alfalfas grown at the Arlington Experimental Farm*—Continued.

AVERAGES OF FOUR GROUPS.

Numbers assigned to plants.	Variety or strain and origin of seed.	Counts made.	Stomata per sq. mm.
		Number.	*Number.*
	Medicago falcata	32	185
	Intermediate alfalfa	29	231
	Variegated alfalfa	33	211
	Ordinary alfalfa	41	292

STEM CHARACTERS OF VARIEGATED ALFALFA.

The decumbent growth of the stems of most forms of *Medicago falcata* is the most noticeable characteristic, while the upright growth of ordinary alfalfa is an equally salient character. The intermediate forms show such a tendency to this decumbent growth that it materially reduces their agricultural value. Variegated alfalfa, however, shows only a slightly greater tendency to lodge than does the ordinary alfalfa. This handicap should be given consideration in the sections to which ordinary alfalfa is adapted, but in localities where ordinary alfalfa can not be successfully produced this drawback is negligible. In this connection it may be mentioned that commercial sand lucern observed on August 8, 1908, in the testing fields of the Kansas Agricultural Experiment Station had lodged somewhat, whereas the ordinary alfalfa grown alongside was upright. The Grimm has also been found to lodge more than does the ordinary alfalfa. In August, 1907, it was observed on the testing plots of the Nebraska Agricultural Experiment Station, at Lincoln, Nebr., that the Grimm alfalfa had lodged more than any of about thirty other lots under test. This experiment included seed from Turkestan, Europe, and the Western States. A year later the same plots were observed shortly after having been cut. The long decumbent stubbles indicated that the lodging in this strain had again been greater than in any of the other lots under test. At Alma, Nebr., the Grimm alfalfa has lodged rather badly on the bottom lands during the past two years. Plate II, figure 3, shows the lodged condition of the field in 1907. The lodging of this same field in 1908 was so bad that after removing the second crop it was deemed necessary to cut the field again to remove the long decumbent stubbles which it was feared would materially retard the gathering of subsequent crops. The stubble hay thus procured was sufficient to pay for the cost of mowing, raking, and stacking, although the product was entirely devoid of leaves. On the adjoining upland this strain did not lodge, owing to the less rank growth. The stems of variegated alfalfa are somewhat more inclined to be four angled than are the stems of ordinary alfalfa. Many of the individual plants of *Medicago falcata* show this character. The white lines at the angles of the stems are usually more conspicuous in the cured hay of variegated alfalfa than has been noted in similar stems of ordinary alfalfa.

ABNORMAL INFLORESCENCES OF VARIEGATED ALFALFA.

The common presence of abnormal inflorescences is worthy of special note, as in but very few instances have any of the abnormalities here mentioned been observed in ordinary alfalfa, which if they are present certainly occur much less frequently than in their progeny. (See Pls. VIII and IX.)

Duplication of floral parts.—Flowers with some of their floral parts duplicated have been observed in Grimm alfalfa, commercial sand lucern, and Wheeler alfalfa. This phenomenon usually takes the form of a double keel, though two standards are sometimes present. This is to a certain extent a hereditary character, since the progeny of a single individual of variegated alfalfa has been observed to show a decided tendency to produce flowers with extra-floral parts. One flower with three keels and three standards has been observed in the Wheeler alfalfa.

Crowded inflorescences.—It is a rather common occurrence for the racemes to be subcorymbose toward the top of the plant and to be largely borne there. This phenomenon has been observed in Grimm alfalfa, commercial sand lucern, and Wheeler alfalfa. (See Pl. VIII.) Another tendency observable in the three strains just mentioned is toward the production of whorled racemes, or at least two racemes from the same height and side by side on the main axis. Forked racemes have been observed, and in a few cases the racemes have shown only a small lateral branch with one to several flowers. In some of these cases it has been noted that the subtending bract of the small branch sometimes assumes the form of a narrow-bladed leaflet. These phenomena have been noted in the Grimm alfalfa, sand lucern, Wheeler alfalfa, and also in the variegated alfalfa from Chinese Turkestan. The crowding of the flowers reaches its apparent climax in the compound racemes noted in the Grimm alfalfa and in the Wheeler alfalfa. (See Pl. IX.) In the latter the flowers are borne in sufficiently open clusters to permit the setting of abundant seed crops, although many of the flowers are too crowded to set seed or even to produce normal flowers. The plant observed in the Grimm alfalfa had its flowers crowded so closely together that many of them failed to set seed. Some of the flowers showed duplications of floral parts. A few plants have been observed in the Wheeler alfalfa which have their flowers reduced to minute bracts borne in doubly compound racemes. (See Pl. IX, D.) Occasionally a perfect flower is to be noted in the small, dense, yellowish clusters of minute aborted flowers. Inbred seed of the compound-racemed alfalfa has produced some plants bearing minute aborted flowers. These have been observed on a plant growing at Rocky Ford, Colo. (Pl. IX, E), and this phenomenon has been reported by Mr. P. K. Blinn, of that place, as having occurred in a locality 50 miles east of Rocky Ford. In neither case has it been possible to determine whether or not these plants were associated with variegated alfalfa, although many of the isolated plants in the vicinity of Rocky Ford and eastward have been observed to possess variegated flowers as well as other characters which make it reasonable to associate these forms with the variegated group of alfalfa. This is apparently the phenomenon noted in *Medicago lupulina* and described by Schmidt as a new species.[a] This is now regarded as merely an abortive form of *Medicago lupulina*. It has also been observed in *Medicago falcata*.[b]

A species of a leaf-spot disease (*Alternaria* sp.) has been observed on the minute bracts which had replaced the floral parts. This, however, was presumably subsequent to the production of the abnormality.

It has occasionally been noted that the subtending floral bract may assume the form of a narrow leaflet. This has been observed in Grimm alfalfa. One plant of *Medicago falcata* has also been observed to show this same phenomenon on its racemes, but with two exceptions this is the only instance where these abnormalities have been observed by the author in either of the parental forms.

PHENOLOGICAL CHARACTERISTICS OF VARIEGATED ALFALFA.

In earliness of starting in spring,[c] as well as in earliness of blooming, the variegated alfalfas appear to exceed the ordinary kinds. This was noticeable in the experimental plots near Washington, D. C. In these plots the hardy alfalfas bloomed about three days in advance of the ordinary alfalfas in the spring of 1908. The earliness of blooming of the Grimm alfalfa and Canadian alfalfa was noted at Fayetteville, N. Y., and Silverdale, Ontario, respectively. At Fayetteville the Grimm alfalfa was being grown in comparison with several other lots of alfalfa, including those from southern Europe, Texas, Utah, Montana, and elsewhere. The Grimm alfalfa was in full bloom on July 12, whereas the other alfalfas were at that time only commencing to bloom. At Silverdale, Ontario, a field of variegated alfalfa was observed in full bloom, whereas a field of ordinary alfalfa alongside it and which had been cut the same day about six weeks previous was not more than one-tenth in bloom. This same phenomenon was also noted at Brookings, S. Dak., in connection with the Simbirsk alfalfa (S. P. I. No. 13857). Near Almont, N. Dak., the commercial sand lucern was observed to be setting seed on July 25, while the associated plots of Turkestan and Montana-grown alfalfa were in bloom but had not commenced to set seed. On October 28, 1908, a series of observations was made of numerous regional lots of alfalfa under test at the Arlington Experimental Farm. The only sorts observed to be setting seed were the South American and the hardy alfalfas. This ability to produce flowers and seed during the entire month of October in the vicinity of Washington is noteworthy, since the mean temperature for the month was 58° F., as compared with 78° for July and 73° F. for August, which are regarded as the best months for seed production. This also affords a possible explanation for the recognized ability of the Canadian and Grimm alfalfas to set seed in Ontario and Minnesota, respectively. There is also apparently greater ability to set seed under humid conditions than is possessed by ordinary alfalfa, and this may lead to the extension of the seed-producing area in the sections which are now regarded as being possessed of too great a rainfall for the successful production of alfalfa seed. As will be noted elsewhere, the heaviest seeding plants at the Arlington Experimental Farm were the selections made from the fields of variegated alfalfa. In this connection reference should also be made to the fact that a field of Wheeler alfalfa at Bridgeport, Kans., has produced successful crops of seed during each of the five years from 1905 to 1909, although none of the years was characterized by the extremes of drought usually considered desirable for successful seed crops of ordinary alfalfa.

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[a] *Medicago corymbifera* Schmidt, Linnea, 1829, vol. 4, p. 75.

[b] Koch. Synopsis der Deutschen und Schweizer Flora, 1846, p. 1888. In discussing *Medicago lupulina* a statement is made regarding this abnormal form noted occasionally in the species. A translation of the sentence is as follows: "*Medicago corymbifera* is an abnormal formation such as has been observed frequently in *Trifolium pratense* and rarely in *Medicago falcata*."

[c] In the southern half of the United States the variegated alfalfas are normally later in starting than the ordinary variety.

PHYSIOLOGICAL CHARACTERISTICS OF VARIEGATED ALFALFA.

CHEMICAL COMPOSITION OF VARIEGATED ALFALFA.

Table VI shows the composition of several different strains of hardy alfalfa, as well as that of the parental forms. The samples were taken at or near the period of early bloom. The samples taken at the Arlington Experimental Farm were from the first crop after sowing. Of these S. P. I. Nos. 21247, 21735, 21827, 22416, and 22467 were taken in 1908, and the chemical composition calculated to a water-free basis. The rest were taken in 1907 and are not calculated to a water-free basis.

TABLE VI.—*Chemical composition of several varieties or strains of variegated and other alfalfas.*[a]

S. P. I. number of sample.	Variety or strain.	Locality where sample was obtained.	Moisture.	Ether extract.	Ash.	Crude fiber.	Crude protein.	Nitrogen-free extract.
19534	Medicago falcata	Arlington Experimental Farm	5.13	3.84	13.21	17.37	18.88	41.57
20571	Intermediate	do	6.95	2.75	11.20	19.95	18.69	40.46
18470	Commercial sand lucern (variegated)	do	5.71	2.72	12.18	19.28	19.69	40.42
16599	do	do	5.90	2.24	13.74	18.97	19.63	39.52
12991	Grimm alfalfa (variegated)	Alma, Nebr. (lowland)	5.36	2.08	10.31	28.30	20.19	33.76
Do	do	Alma, Nebr. (upland)	5.89	2.41	11.29	22.87	20.63	36.91
21733	Grimm alfalfa (variegated), Nebraska grown	Arlington Experimental Farm		2.87	13.42	23.51	18.53	38.71
21827	Grimm alfalfa (variegated), Montana grown	do		2.92	11.05	23.52	20.14	39.15
22467	Old Frankish lucern (variegated)	do		2.99	14.39	20.19	20.36	38.81
14069	Baltic alfalfa (variegated)	do	6.08	2.46	12.75	20.66	19.31	38.74
13520	German (Pfalz) alfalfa (variegated)	do	6.05	2.31	15.93	18.76	19.31	37.64
18629	Canadian alfalfa (variegated)	do	5.10	2.74	14.03	18.19	19.56	40.38
21247	do	do		2.97	10.29	25.64	19.17	38.86
19508	Wheeler alfalfa (variegated)	Bridgeport, Kans	5.45	2.00	11.10	17.74	19.13	44.58
1159	Turkestan alfalfa (variegated	Arlington Experimental Farm	5.46	2.18	23.35	17.59	17.81	33.61
9450	Turkestan alfalfa	do	4.97	2.22	19.57	20.65	18.13	34.46
18751	do	do	5.02	2.77	10.68	20.06	19.06	42.11
Do	do	Chico, Cal	6.28	2.60	11.86	23.96	15.94	39.36
19522	Provence alfalfa	do	6.00	2.15	11.42	25.94	16.25	38.24
22416	do	Arlington Experimental Farm		3.07	11.76	22.60	18.61	40.98
17698	Ordinary alfalfa, Montana grown	Chico, Cal	6.17	2.00	14.84	23.46	17.81	35.72
18827	Ordinary alfalfa	do	5.98	2.07	14.18	24.12	17.50	36.15
Commercial	do	Mecca, Cal	5.96	2.09	11.29	24.75	17.81	38.10
Do	do	Mesilla Park, N. Mex	5.64	2.36	9.99	22.96	16.63	42.42

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[a] Analyses made by the Bureau of Chemistry.

COLD AND DROUGHT RESISTANCE OF VARIEGATED ALFALFA.

In addition to the variegated strains of alfalfa being hardier than corresponding strains of ordinary alfalfa, it has also been observed that the variegated alfalfas are usually somewhat more drought resistant than the ordinary variety. The apparent correlation between hardiness and drought resistance in alfalfa has never received an entirely satisfactory explanation. The fact that the hardy drought-resistant yellow-flowered alfalfa constitutes a small percentage of the parentage of these variegated strains suggests the origin of these characteristics. It is possible that the smaller number of stomata observed in both the *Medicago falcata* and the variegated alfalfa as shown in Table V may offer a partial explanation for the drought resistance, but it is difficult to see how this would materially affect the hardiness of the strains unless the growth be rendered less succulent during the periods of relative high winter temperatures which sometimes occur. The Grimm alfalfa, sand lucern, and Baltic alfalfa have all proved relatively drought resistant. In the tests referred to in discussing the respective strains, the Grimm alfalfa has proved drought resistant in North Dakota, South Dakota, and Nebraska. The sand lucern has shown itself to be drought resistant in North Dakota, Montana, Nebraska, eastern Colorado, Utah, and eastern Washington. (See Pl. VII, figs. 1 and 2.) The Baltic alfalfa has proved drought resistant at Highmore, S. Dak.

Table VII indicates the weights of hay reported to have been produced without irrigation by Mr. Paris Gibson, of Great Falls, Mont., in 1908. Each plot was 1 acre in extent and the entire product was weighed. The hay was weighed when in the usual condition for stacking and was not entirely dry.

TABLE VII.—*Yield of hay of several varieties and strains of variegated and other alfalfas, Great Falls, Mont., 1908.*

S. P. I. number.	Variety or strain.	Yield per acre.
		Pounds.
19896	Canadian alfalfa (variegated)	7,505
20457	Sand lucern (variegated)	6,425
20844	Turkestan alfalfa	5,400
19508	Wheeler alfalfa (variegated)	5,430
19566	Nebraska dry-land alfalfa	4,700

The normal rainfall at Great Falls, Mont., is about 14 inches.

In the spring of 1908 a number of cooperative tests with several strains of alfalfa, including the Grimm alfalfa and commercial sand lucern, were inaugurated in cooperation with the state experiment stations of South Dakota, North Dakota, Minnesota, and Wisconsin.

In the majority of these tests where there were any marked differences the Grimm alfalfa proved hardier than any other of the strains under test. In a number of instances all varieties winterkilled. In but one case was the winterkilling in the plots of sand lucern and Grimm alfalfa such as to necessitate the reseeding of the former without reseeding the latter. The actual percentages of winter mortality of a number of these plots in different States were obtained by comparing the number of surviving plants with the number of nonsurviving plants in a typical square yard in the spring of 1909. The average of all tests where actual counts were made showed that 19 per cent of the counted plants of the Grimm alfalfa winterkilled, as compared with 39 per cent for the sand lucern. The average winterkilling of the different importations of the sand lucerns varied from 9 per cent for one commercial strain, the winterkilling percentage of which was obtained only at Dickinson, N. Dak., to 41 per cent for one introduction (S. P. I. No. 21269), which was presumably adulterated with ordinary alfalfa. In this connection it should be noted that there is always a gradual reduction in the number of plants actually present from season to season in any alfalfa field as the field becomes older. Not all of the winter mortality is due to the actual freezing out of the plants, as considerable reductions of stands are to be observed in alfalfa fields in the southern part of the United States.[a]

The average calculated weight of hay per acre for the first cutting of all tests where yields were secured from adjoining plots of Grimm alfalfa and sand lucern was 2,266 pounds for the commercial sand lucern, as compared with 2,206 pounds for the Grimm alfalfa.

At Dickinson, N. Dak., the North Dakota substation made a comparative test of a number of different alfalfas which were drilled in during the spring of 1908. These alfalfas experienced a winter temperature as low as −31° F. with little or no snow on the ground during the winter of 1908–9. (See Pl. VI, figs. 1 and 2.) The percentage of winterkilling as calculated from the count of the dead and living plants in the spring of 1909, together with the weight of hay secured from the first cutting from plots ranging from one-fourth to one-half acre, is indicated in Table VIII.[b]

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[a] A full stand of alfalfa at the end of the first season usually shows from 20 to 50 plants per square foot, while 8 plants per square foot will present a good stand during the second season of growth. If there are 4 plants per square foot uniformly over the field during the third season of growth, the stand will appear perfect. It is thus evident that a relatively small percentage of hardy plants in a strain may enable the stand to prove a success for a series of years and still lose a considerable percentage of its plants during the first few winters.

[b] This cooperative experiment was inaugurated by Prof. L. A. Waldron, superintendent of the substation at Dickinson, N. Dak., and the data were obtained by Mr. C. H. Clark, under the direction of Mr. O. J. Grace, acting superintendent.

TABLE VIII.—*Percentage of plants of variegated and ordinary alfalfas winterkilled at Dickinson, N. Dak., in 1908–9, with yield of hay in first cutting of crop thereafter.*

Variety or strain.	Winter-killed plants.	Yield of hay per acre.
	Per cent.	*Pounds.*
Grimm alfalfa (variegated)	3	1,411
Sand lucern (variegated)	20	1,826
Turkestan alfalfa	21	1,179
Canadian alfalfa (variegated)	27	538
Utah alfalfa	89	1,173

In a number of instances in North Dakota stands of red clover winterkilled on farms where the variety tests of Grimm alfalfa, sand lucern, and Turkestan alfalfa went through the winter without serious injury.

IMPORTANCE OF VARIEGATED ALFALFA FOR BREEDING AND SELECTION WORK.

In any field of variegated alfalfa there are present numerous forms which have apparently resulted from the splitting of the mixed or multiple hybrids. These widely varying forms constitute an excellent basis for the selection of promising individuals. Futhermore, most of the important strains of variegated alfalfa have been produced under rather severe conditions of climate and soil. In this way the nonhardy individuals have been weeded out. As a specific instance of the possibilities of selection in fields of variegated alfalfa, it may be mentioned that the most promising selections for seed and hay producing qualities made by the United States Department of Agriculture have been secured from fields and plots of variegated alfalfa.

In propagating the selections made from fields of variegated alfalfa it has been observed that inbred seed comes reasonably true to type. Outbred or open-pollinated seed, however, breaks up to a considerably greater extent than does inbred seed. It is unsafe to generalize on the comparatively few preliminary experiments which have been possible up to this time, but the indications are that any really desirable character may be considered to be inheritable to a large degree. A heavily seeding plant usually produces a heavy-seeding progeny. It has been noted, however, where the plant has been crossed with pollen from inferior individuals that the seed-producing power has been somewhat reduced. The plants from the inbred seed, however, have little variation from the parent in their seed-producing ability. It is an open question, however, whether it will ever be desirable except in special instances to breed narrow types of alfalfa. The self-bred plants in some instances have not appeared to be quite so vigorous as the open-fertilized progeny from the same mother plant, and continued inbreeding may be found to be so detrimental to the vigor of the offspring as to make it impracticable to continue this operation indefinitely.

On the other hand, with numerous types at hand in a given strain there will be a wider range of adaptability to diverse conditions, the intercrossing will serve to maintain the vigor of the plants, and the diversity of habit and characteristics will enable enough plants to survive under a special set of conditions to furnish a satisfactory stand after the adapted forms have perished. The continued intercrossing among the mixed hybrids will induce further variation which will form a desirable basis for either natural or artificial selection. The diversity of soil and climatic conditions which the alfalfa in this country is called upon to withstand calls for strains adapted to as wide a range of severe conditions as possible.[a]

METHODS OF BREEDING NARROW TYPES OF VARIEGATED ALFALFA.

When it is considered desirable to establish narrow types of alfalfa adapted to a particular set of conditions or for a special purpose the hardy alfalfa group constitutes an excellent basis for the preliminary selections, owing to the variation in forms already present. These alfalfas being a mixed race will probably withstand close breeding better than will ordinary alfalfa.

In establishing a strain from a single individual, self-fertilization is necessary.[b] It is usually desirable at first to propagate the mother plant vegetatively by cuttings to secure abundant stock for seed production and to guard against the possible loss of the mother plant.[c]

The necessary inbreeding can best be done by hand, and while the effects of continued in-and-in breeding have not been worked out as yet this process can at least be continued until the vigor of the progeny is seen to be affected, when it can be cross-pollinated with other individuals approaching the desired type. To prevent cross-breeding in connection with the inbred or control-bred plants isolation of some kind is necessary. This is best accomplished on a small scale by inclosing the stalk in a pouch made of mosquito netting, gauze, or perforated paper. (See Pl. III, fig. 4.) On a slightly larger scale it is practicable to use a screened cage to keep out the insects. When, however, the work is to be done on an even more extensive scale and many plants used, geographical isolation is advisable. The plot of rooted cuttings of the selected plant should be grown as far as possible from other fields of alfalfa.

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[a] Shull, George H. The Composition of a Field of Maize. Proceedings, American Breeders' Association, vol. 4, 1908, pp. 296-301.

[b] Westgate, J. M. A Method of Establishing a Strain of Alfalfa from a Single Individual. Proceedings, American Breeders' Association, vol. 2, 1906.

[c] Westgate, J. M., and Oliver, G. W. The Application of Vegetative Propagation to Leguminous Forage Plants. Bulletin 102, pt. 4, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1907.

It has been found necessary in nature that the explosive mechanism in the alfalfa flower be tripped or exploded in order that seed be set.[a] To release this explosive mechanism it is necessary to apply pressure to the keel. This can be done with any hard object. When several plants are to be worked the method of pinching the entire raceme, as suggested by Roberts and Freeman, can be used to advantage.[b] If, however, the work is to be done on an extended scale it is suggested that a more rapid method be used. The plant should be grasped with the hand at the base and successive pressure or strokes exerted at intervals toward the top.[c] By this method it is possible to work ten plants a minute. The successive pressures will trip a majority of the flowers, while a second working of the plants will trip most of the remaining untripped flowers.[d]

When large numbers of cuttings are grown isolated from other alfalfa fields the possible effect of insects carrying pollen from distant fields can be largely overcome by keeping the flowers artificially tripped by working them each morning during the blooming period. It does not appear probable that the insects which accomplish the natural tripping exert any effect on the stigma of the flower after it has once been tripped by other agencies.

If, however, it is desired to produce in quantities cross-bred seed of known male parentage, rows of cuttings of the selected parents can be alternated and the insects allowed to bring about cross-pollination. The relative potency of the pollen of other plants over that of the plant's own pollen on its stigma has not been fully worked out, but the results indicate that there is at least a slight degree of prepotency on the part of the pollen of the other plant, and this, if true, will cause the majority of the seeds produced to be cross-bred. The crossing of each individual flower by hand is such a tedious process as to be impracticable where any but a very few seeds are desired.[a]

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[a] Burkill, I. H. On the Fertilization of Some Species of Medicago L. in England. Proceedings, Cambridge Philosophical Society, 1894. See also Brand, Charles J., and Westgate, J. M., "Alfalfa in Cultivated Rows for Seed Production in Semiarid Regions." Circular 24, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1909.

[b] Methods of Breeding Alfalfa. Bulletin 151, Kansas Agricultural Experiment Station.

[c] Westgate, J. M. Methods of Breeding Alfalfa. Proceedings, American Breeders' Association, vol. 5, 1909.

[d] In an experiment performed at the Arlington Experimental Farm, near Washington, D. C., this method of artificial tripping, in addition to the normal visitation of insects, was found to effect an increase of 25½ per cent in the production of pods over that of adjoining rows of sister plants which had been produced from cuttings from the same individual but which were tripped only by natural agencies, presumably insect visitors.

OPTIMUM PROPORTION OF MEDICAGO FALCATA IN VARIEGATED ALFALFA.

It has not yet been determined what is the best relative proportion of the yellow-flowered alfalfa in the ancestry of hardy alfalfa for any specific purpose, as, for instance, for drought resistance. This is a very important question, since it is possible to vary to a certain degree the relative proportions of the two species in the hybrid progeny. The agronomic disadvantages of the forms possessing equal proportions of the two species in their ancestry as compared with the forms which possess probably from 5 to 10 per cent of *Medicago falcata* in their ancestry indicate that the latter proportion is somewhat near the proper quantity. The experiments referred to under the head "Re-creation of variegated alfalfa" are being continued with the idea of determining the agronomic as well as the botanical characteristics of the crosses as the proportion of ordinary alfalfa in their ancestry is increased. The reciprocal prepotency of the pollen of the two species makes it appear probable that a single row or a few scattered plants of *Medicago falcata* will affect a relatively large number of the more numerous individuals of ordinary alfalfa. In this way a relatively small amount of the less common yellow-flowered alfalfa can be made to serve as a basis for comparatively large amounts of hybrid progeny.

Experiments are also under way to determine to what extent the amount of variation in flower color is correlated with the hardiness of the different strains in question. It is being taken as a working hypothesis that the percentage of flowers of other color than the ordinary violet is an index to the percentage of the yellow-flowered alfalfa in the ancestry of a given strain. It may also prove an index to its relative hardiness. It must not be considered, however, that these hypotheses do more than indicate what selections should be made for the actual experimental trials of the different lots. The crucial test is the relative ability of the different strains to withstand unfavorable conditions of soil and climate, and these can only be determined definitely by actual tests of the different strains under each given set of conditions. It is thought, however, that the observed correlation of the flower-color variation in the fields of known hardiness may be valuable in selecting other strains for severe tests as to hardiness and general adaptability to unfavorable conditions.

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[a] Oliver, G. W. New Methods of Plant Breeding. Bulletin 167, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1910.

COMMERCIAL ASPECTS OF THE HARDY-ALFALFA PROBLEM.

The demand for alfalfa adapted to conditions too severe for the successful production of ordinary alfalfa will probably always exceed the supply. It is important, therefore, that every possible source of alfalfas that are even suspected of being hardy be investigated to make possible the maximum seed-bearing acreage of this group of alfalfas. Until the hardy character of any lot of variegated alfalfa is appreciated the seed will be bulked with that of ordinary alfalfa and in this way become lost to those who stand most in need of such a product. On the other hand, there will always be a temptation on the part of seedsmen and others to adulterate the seed of any hardy alfalfa with seed of the less hardy varieties. It would be a most desirable state of affairs if arrangements could be made whereby the grower of any hardy alfalfa would market his own alfalfa seed in sealed bags of a certain minimum weight and make sales with a guarantee as to the seed being true to name. Tests are under way to determine whether there are any noteworthy exceptions to the apparent rule that all variegated alfalfas are comparatively hardy and drought resistant, and until the results of such tests are available the seed of any of the variegated and presumably relatively hardy alfalfas which have not been fully tested should be experimented with upon a small scale until their value for a particular set of conditions is demonstrated.

It is important that hardy alfalfa seed be grown under as severe conditions as will permit of profitable seed production. The variability of the alfalfa plant makes possible the selection and establishment of hardy strains possessing other desirable characteristics. For this reason it is very desirable that the practice of growing and selling seed from pedigreed strains be encouraged in every possible way.

The supply of the Grimm alfalfa and even of the Canadian alfalfa will for years be probably far short of the demand. The source of the seed of these alfalfas can be traced, as the location of the fields is known, and in addition the seed has usually been free from noxious weeds. In but few instances has attempted fraud been noted. The utilization of imported commercial sand lucern in this country is open to some dangers which should be given due consideration. In the first place, the seed is apt to contain seed of noxious weeds, such as buckhorn or English plantain (*Plantago lanceolata*). In the second place, the seed can not be readily traced in its origin and is open to the danger of having been adulterated with seed of ordinary alfalfa. These handicaps can be largely overcome by growing carefully selected seed of this strain in the most northerly alfalfa seed-producing sections of this country and Canada, so that any nonhardy individuals present in the strain will be speedily eliminated. This seed can then be handled on the same basis as the Grimm and Canadian strains, which are already being grown for seed in this country.

CONCLUSIONS.

The studies of the somewhat isolated instances of specially hardy alfalfa fields have shown that these relatively hardy strains agree quite closely among themselves in their botanical characters and differ noticeably in a number of characters from the ordinary western-grown alfalfa.

The investigations recorded in this bulletin have indicated that the primary explanation of the hardiness of these strains is that they possess a small percentage of the blood of *Medicago falcata* in their ancestry. The hardiness of *M. falcata*, which occurs wild in Eurasia, is attested by its natural growth on the dry, cold steppes of Siberia, far north of the range of ordinary alfalfa (*M. sativa*). In both botanical and agronomic characters these relatively hardy alfalfas show slight but recognizable departures from the corresponding characters of *M. sativa* toward those of *M. falcata*. Subsequent natural selection or selective acclimatization must still be assigned at least a supplemental rôle in the development of the hardiness of the strains, since those lots which have been called upon to undergo severe conditions usually contain a greater proportion of hardy plants than those which have never been subjected to climatic environment so unfavorable as to eliminate the nonresistant forms.

The preliminary comparative field tests of the different variegated alfalfas are of too short a duration to make definite conclusions possible as to their relative value. The tests indicate, however, that under very severe conditions the sand lucern, while much hardier than the ordinary alfalfa, is somewhat less hardy than the Grimm alfalfa, which has been successfully produced in Minnesota for fifty years. The initial seeding of any of the variegated alfalfas should be made on a rather small scale in sections new to these alfalfas. It is suggested that Grimm alfalfa be given the preference in sections presenting very severe winter conditions and that other strains, such as sand lucern and Canadian alfalfa, be more largely utilized in sections where the climate is somewhat less severe, but where it is still too trying for ordinary alfalfa. In regions calling for the hardiest alfalfa such strains as sand lucern should be used as a substitute for Grimm alfalfa when the seed of the latter is not available.

The great variation present among the individuals of the different strains of variegated alfalfa makes them especially promising for breeding and selection work in connection with the further development of improved strains of alfalfa.

DESCRIPTION OF PLATES.

Plate I. Fig. 1.—A mature plant of *Medicago falcata*, showing nearly prostrate habit. Fig. 2.—A single plant of intermediate alfalfa, showing decumbent stems. Fig. 3.—Plants of intermediate alfalfa in a nursery row, showing partially prostrate habit. Fig. 4.—A single plant of ordinary alfalfa, showing upright habit.

Plate II. Fig. 1.—A single plant of commercial sand lucern with the stems slightly decumbent. Fig. 2.—A single plant of Grimm alfalfa, showing a slight tendency toward prostratism. Fig. 3.—Field of Grimm alfalfa near Alma, Nebr., showing lodging. An adjoining field of the same strain of alfalfa on ground 30 feet higher showed much less lodging.

Plate III. Fig. 1.—A natural hybrid alfalfa plant. This was grown from seed procured from a plant of falcate-podded alfalfa which was grown associated with ordinary alfalfa. The pods showing but one coil are illustrated in text figure 1, *B*. Fig. 2.—A single plant of Grimm alfalfa, showing fairly upright growth and great leafiness. Fig. 3.—Two Grimm alfalfa plants of widely divergent types. These same types are to be observed in other strains of variegated alfalfa, such as commercial sand lucern. Fig. 4.—A single plant of an upright selection of variegated alfalfa. Selected for its upright growth and heavy seed-producing ability. The stake shown is used to support the screen bags used to prevent the entrance of insects when inbred seed is desired in line breeding.

Plate IV. Fig. 1.—A field of Grimm alfalfa near Excelsior, Minn., showing the effects of ice sheets in February, 1906, which similarly injured many old stands of Grimm alfalfa which had been uninjured for thirty years. It will be noted that there is a direct relation between the topography of the field and the injury. Fig. 2.—A field of Canadian alfalfa, showing the effects of ice sheets in February, 1906, at which time many fields in the neighborhood experienced their first serious injury for fifteen years. Photograph taken near Wellandport, Ontario, Canada.

Plate V. Fig. 1.—A field of Grimm alfalfa forty years old, seeded in 1869, near Excelsior, Minn. The immediate foreground, which borders a slough, has given way to native grasses. Fig. 2.—A field of ordinary alfalfa five years old, near Excelsior, Minn. Only a few plants have survived the winters.

Plate VI. Fig. 1.—Field plots of commercial sand lucern (at the right) and of Grimm alfalfa (at the left), Dickinson, N. Dak. The minimum temperature during the preceding winter (1908–9) was —31° F. S. P. I. Nos. 21217 and 21269 (sand lucerns) are shown in the right foreground and in the background, respectively, with S. P. I. Nos. 21287 and 21735 (Montana-grown and Nebraska-grown Grimm alfalfa) in the left foreground and in the background, respectively. The center stake marks the meeting point of the four plots. Fig. 2.—Field plots of Utah alfalfa (in immediate foreground) and of commercial sand lucern (beyond), at Dickinson, N. Dak. A few square feet of the sand lucern plants (S. P. I. No. 21217) had been cut from the front of the plot in making some statistical studies just before the photograph was taken. The Utah alfalfa (S. P. I. No. 12784) shows a patchy stand owing to winterkilling.

Plate VII. Fig. 1.—Cultivated rows of commercial sand lucern (at the left) and of Turkestan alfalfa (at the right), at Sextorp, Nebr. Both were grown in cultivated rows for seed in western Nebraska having a normal rainfall of 15 inches on upland without irrigation. Fig. 2.—Cultivated rows of commercial sand lucern (at the right) and of Brott's dry-land alfalfa (at the left) in the same field shown in figure 1.

Plate VIII. Abnormal inflorescences in various strains of variegated alfalfa: *A*, Grimm alfalfa, showing same arrangement of racemes as in ordinary alfalfa, but with the two lower racemes abnormal branching; *B*, Grimm alfalfa, showing whorled racemes and crowded racemes near top of stalks; *C*, variegated alfalfa selected from Rocky Ford, Colo., showing supernumerary leaflets and racemes approaching the subcorymbose habit; *D*, variegated alfalfa (Wheeler alfalfa) from Bridgeport, Kans., showing subcorymbose racemes; *E*, commercial sand lucern, showing racemes crowded toward top of stalk. One of the lower racemes is forked.

Plate IX. Abnormal inflorescences in various strains of variegated alfalfa in addition to those shown in Plate VIII: *A*, fruiting stem; *B*, flowering stem of plant of variegated alfalfa (Wheeler alfalfa), showing compound racemes crowded toward top of stalk; *C*, an abnormality found in Grimm alfalfa. The flowers are in compound racemes and crowded toward the top of the stalk; *D*, an abnormality found in variegated alfalfa (Wheeler alfalfa). The flower parts are reduced to minute bracts and closely crowded in doubly compound racemes. The mother plant bore an occasional perfect flower; *E*, an abnormality noted in a plant of alfalfa of unknown origin near Rocky Ford, Colo. Inbred seed of *A* and *B* occasionally produces plants showing abnormalities similar to *D* and *E*.

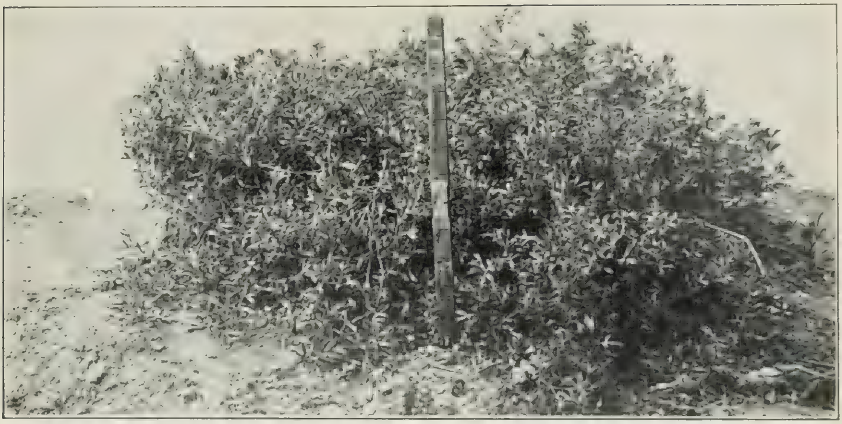


FIG. 1.—A MATURE PLANT OF MEDICAGO FALCATA, SHOWING NEARLY PROSTRATE HABIT.

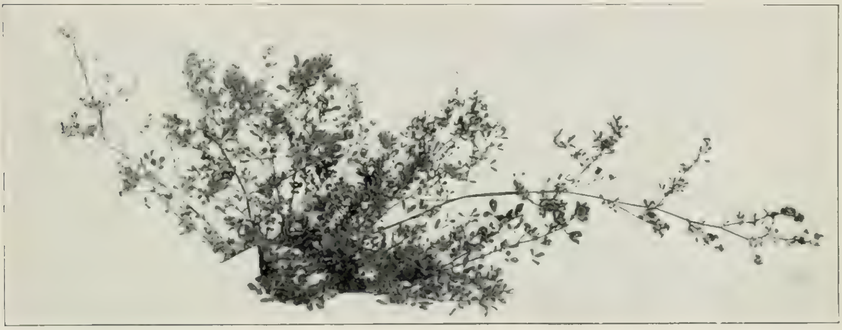


FIG. 2.—A SINGLE PLANT OF INTERMEDIATE ALFALFA, SHOWING DECUMBENT STEMS.

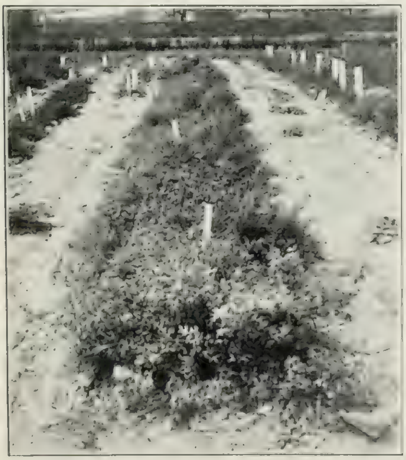


FIG. 3.—PLANTS OF INTERMEDIATE ALFALFA IN A NURSERY ROW, SHOWING PARTIALLY PROSTRATE HABIT.

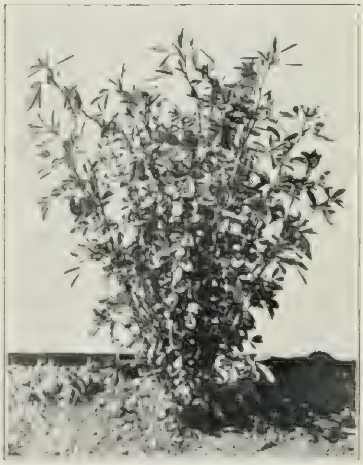


FIG. 4.—A SINGLE PLANT OF ORDINARY ALFALFA, SHOWING UPRIGHT HABIT.

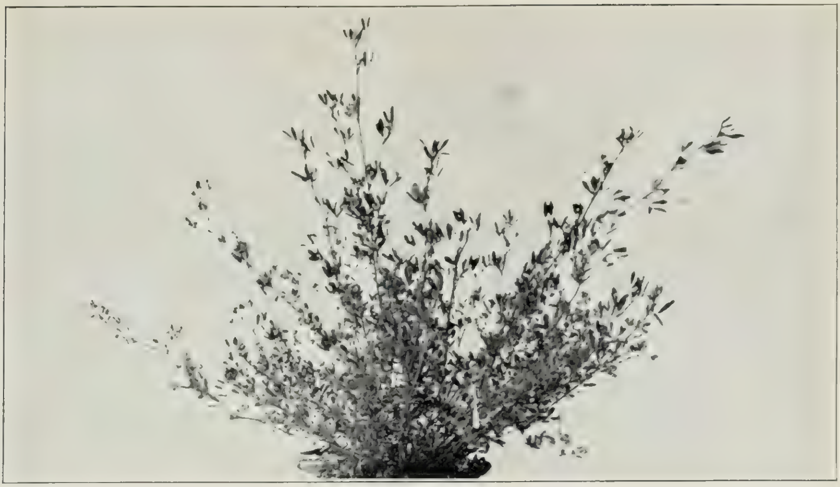


FIG. 1.—A SINGLE PLANT OF COMMERCIAL SAND LUCERN, WITH THE STEMS SLIGHTLY DECUMBENT.

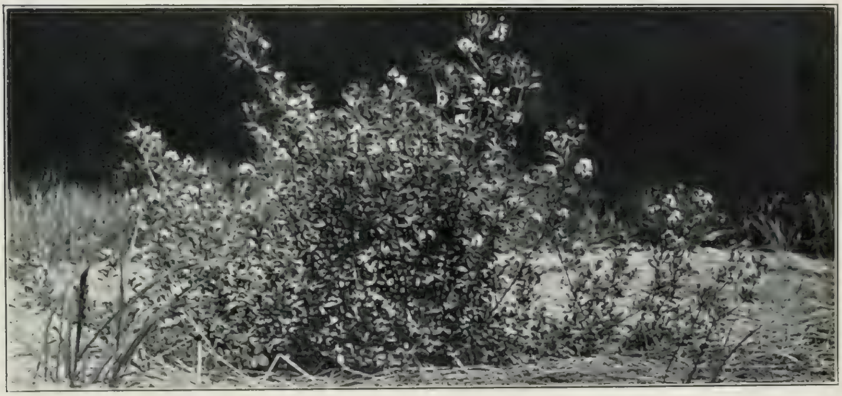


FIG. 2.—A SINGLE PLANT OF GRIMM ALFALFA, SHOWING A SLIGHT TENDENCY TOWARD PROSTRATISM.

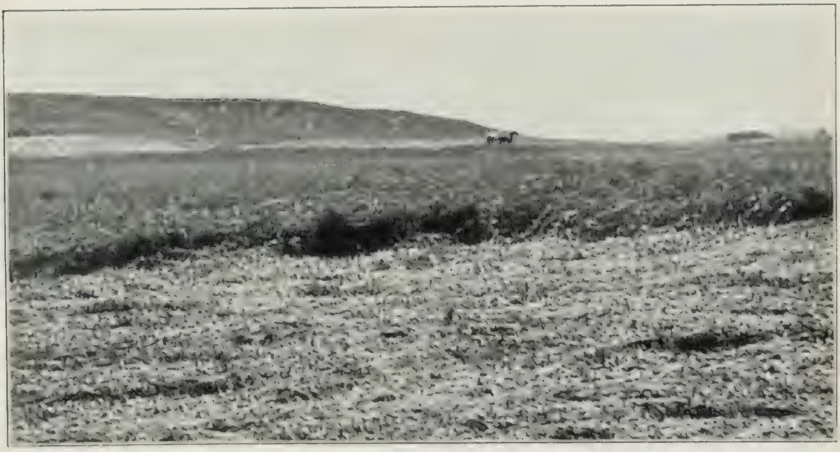


FIG. 3.—A FIELD OF GRIMM ALFALFA NEAR ALMA, NEBR., SHOWING LODGING.

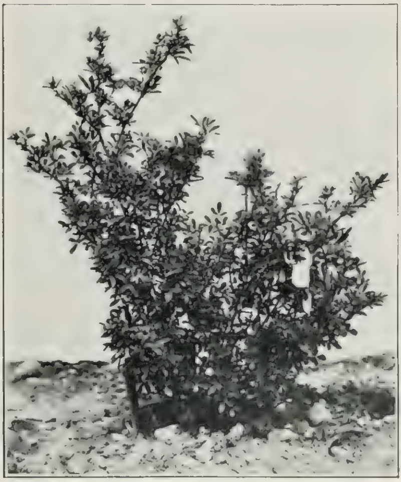


FIG. 1.—A NATURAL HYBRID ALFALFA PLANT.

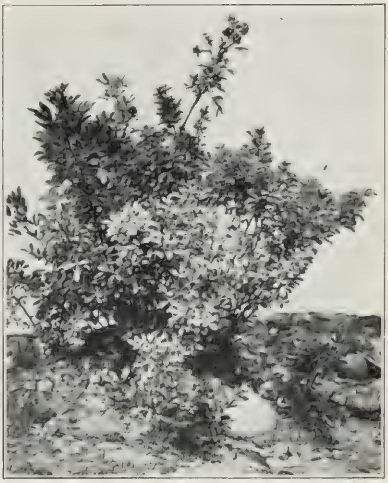


FIG. 2.—A SINGLE PLANT OF GRIMM ALFALFA, SHOWING FAIRLY UPRIGHT GROWTH AND GREAT LEAFINESS.

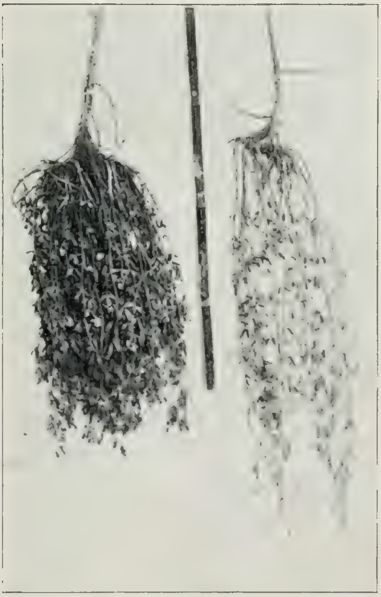


FIG. 3.—TWO GRIMM ALFALFA PLANTS OF WIDELY DIVERGENT TYPES.

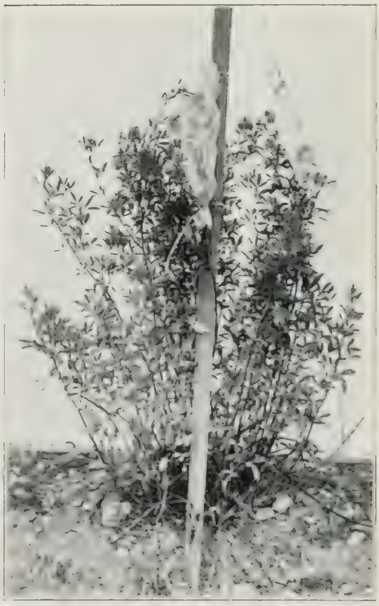


FIG. 4.—A SINGLE PLANT OF AN UPRIGHT SELECTION OF VARIEGATED ALFALFA.

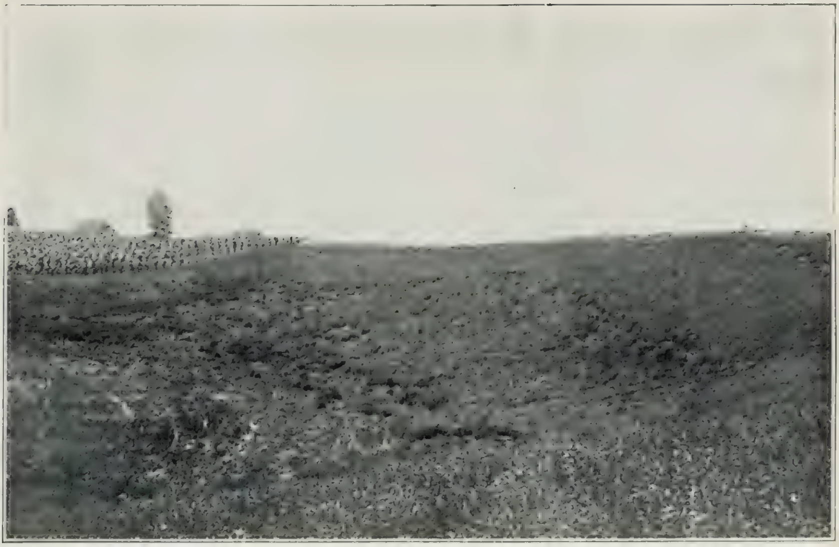


FIG. 1.—A FIELD OF GRIMM ALFALFA NEAR EXCELSIOR, MINN., SHOWING THE EFFECTS OF ICE SHEETS.

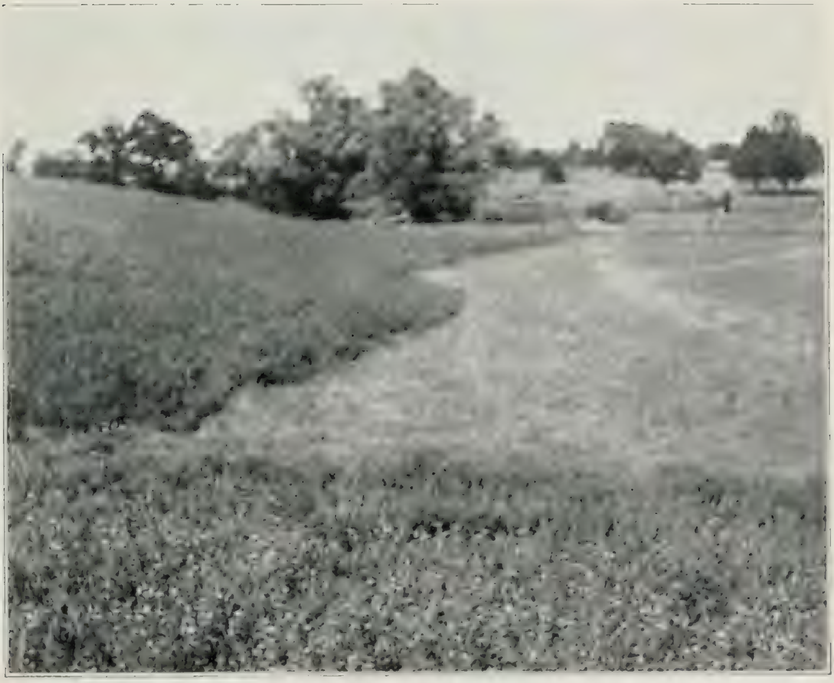


FIG. 2.—A FIELD OF CANADIAN ALFALFA, SHOWING THE EFFECTS OF ICE SHEETS.

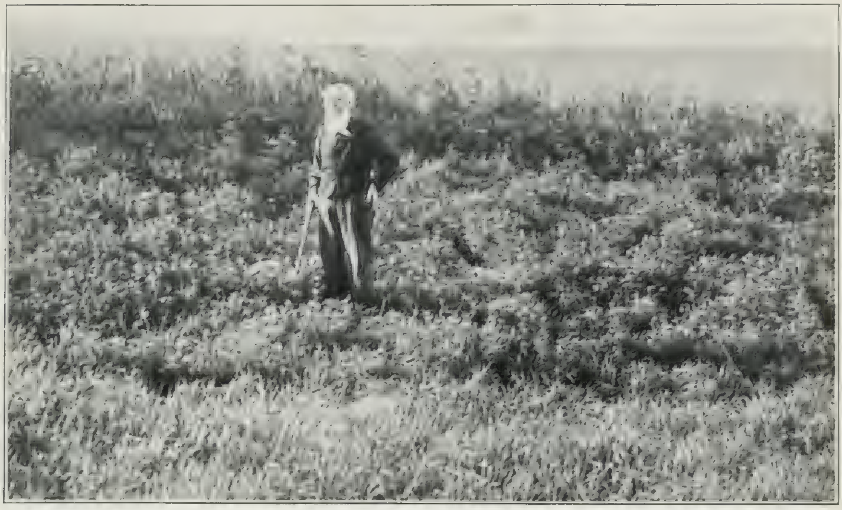


FIG. 1.—A FIELD OF GRIMM ALFALFA FORTY YEARS OLD, NEAR EXCELSIOR, MINN.

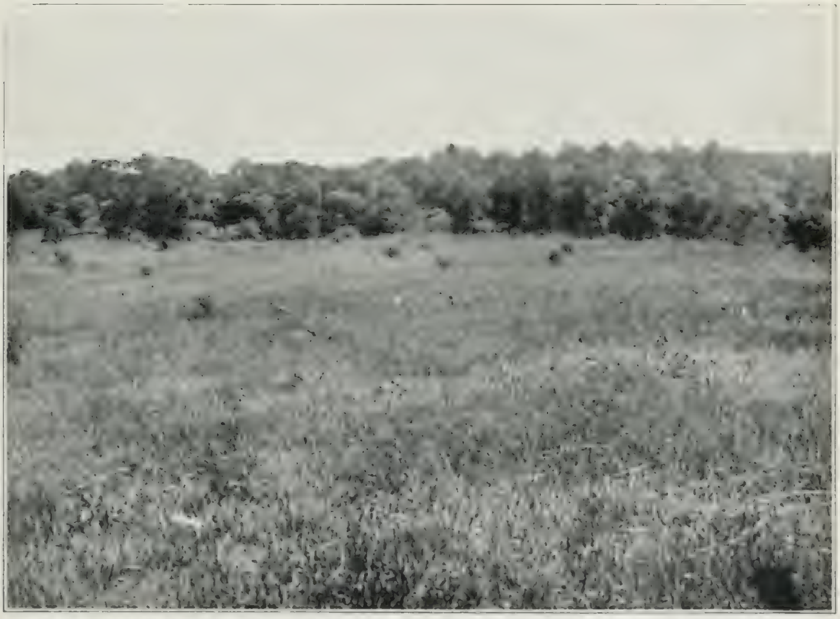


FIG. 2.—A FIELD OF ORDINARY ALFALFA FIVE YEARS OLD, NEAR EXCELSIOR, MINN.

Only a few plants have survived the winters.

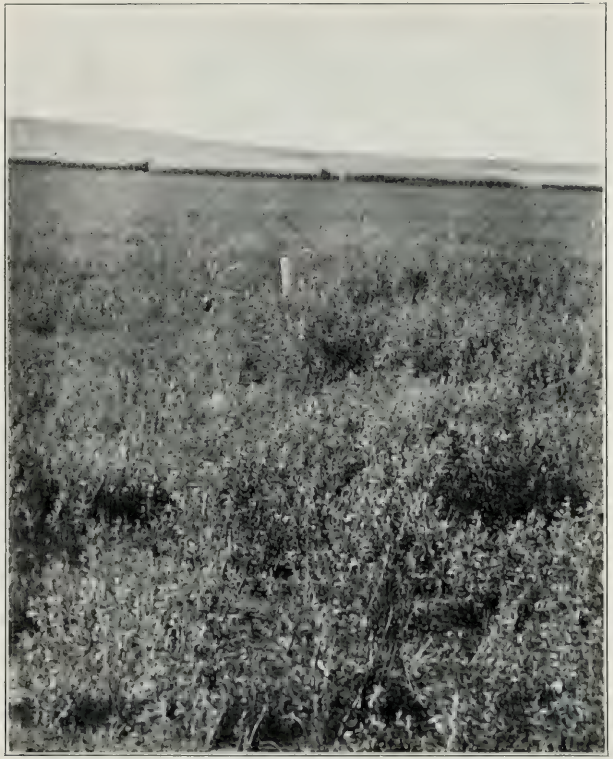


Fig. 1.—Field Plots of Commercial Sand Lucern (at the Right) and of Grimm Alfalfa (at the Left), at Dickinson, N. Dak.

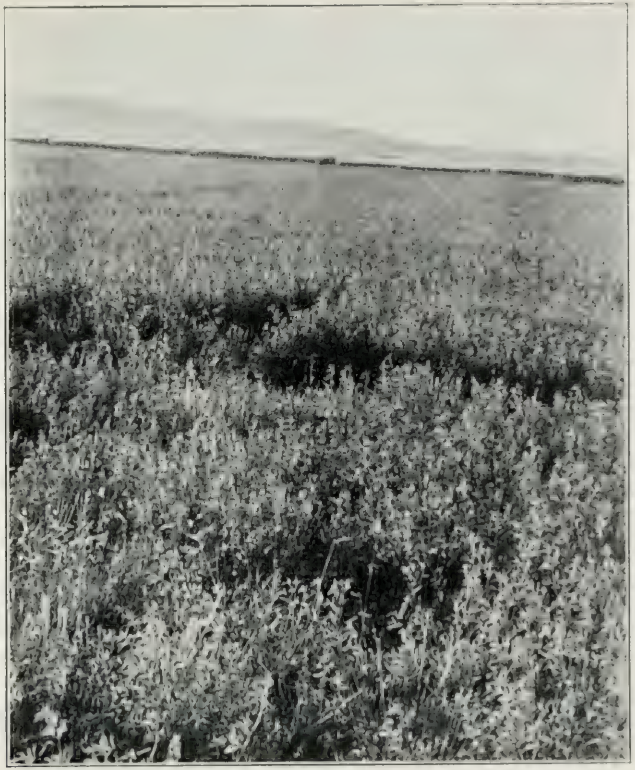


Fig. 2.—Field Plots of Utah Alfalfa (in Immediate Foreground) and of Commercial Sand Lucern (Beyond), at Dickinson, N. Dak.

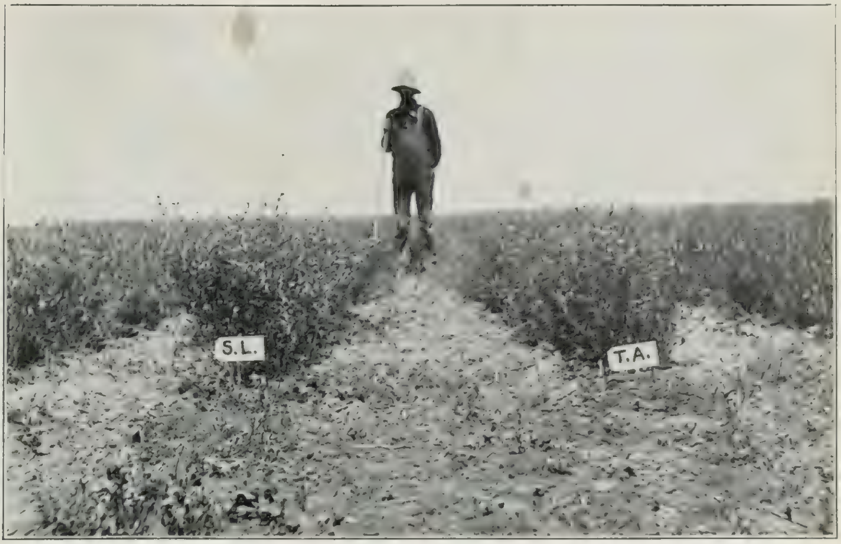


FIG. 1.—CULTIVATED ROWS OF COMMERCIAL SAND LUCERN (AT THE LEFT) AND OF TURKESTAN ALFALFA (AT THE RIGHT), AT SEXTORP, NEBR.

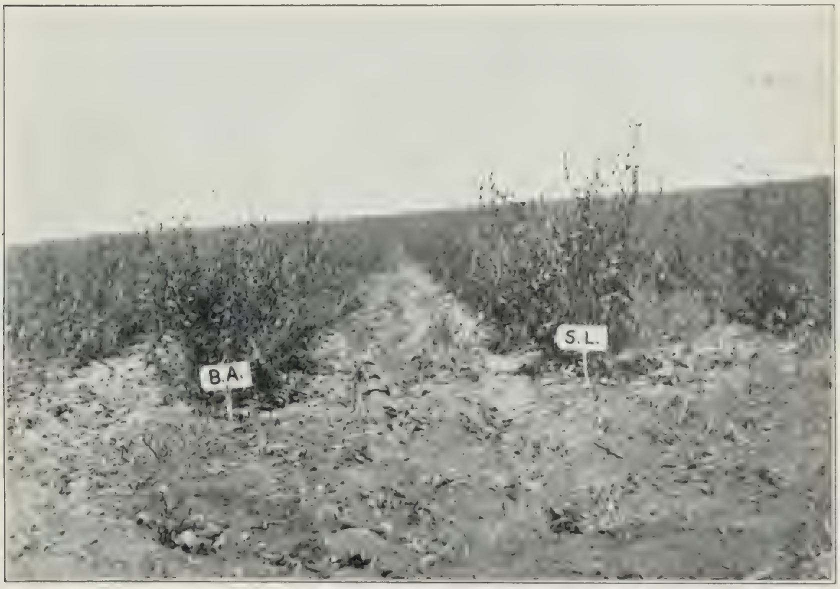
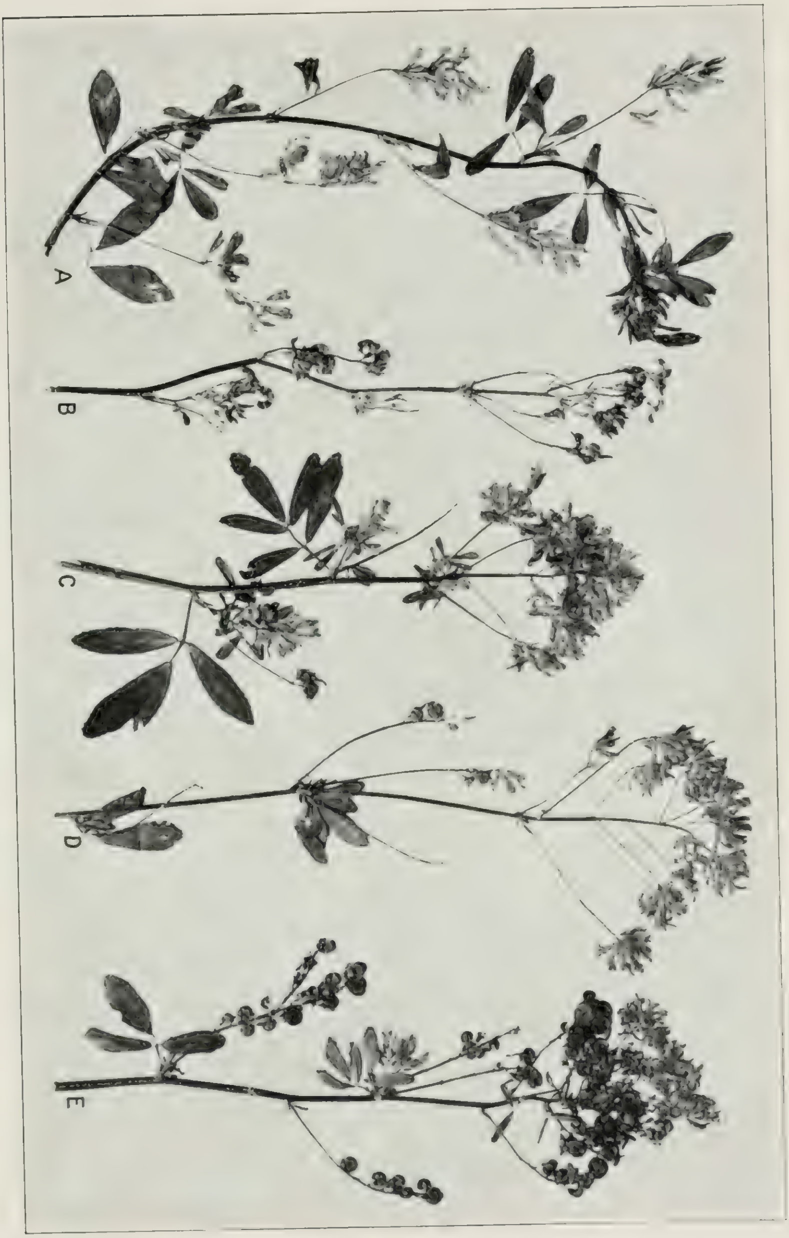
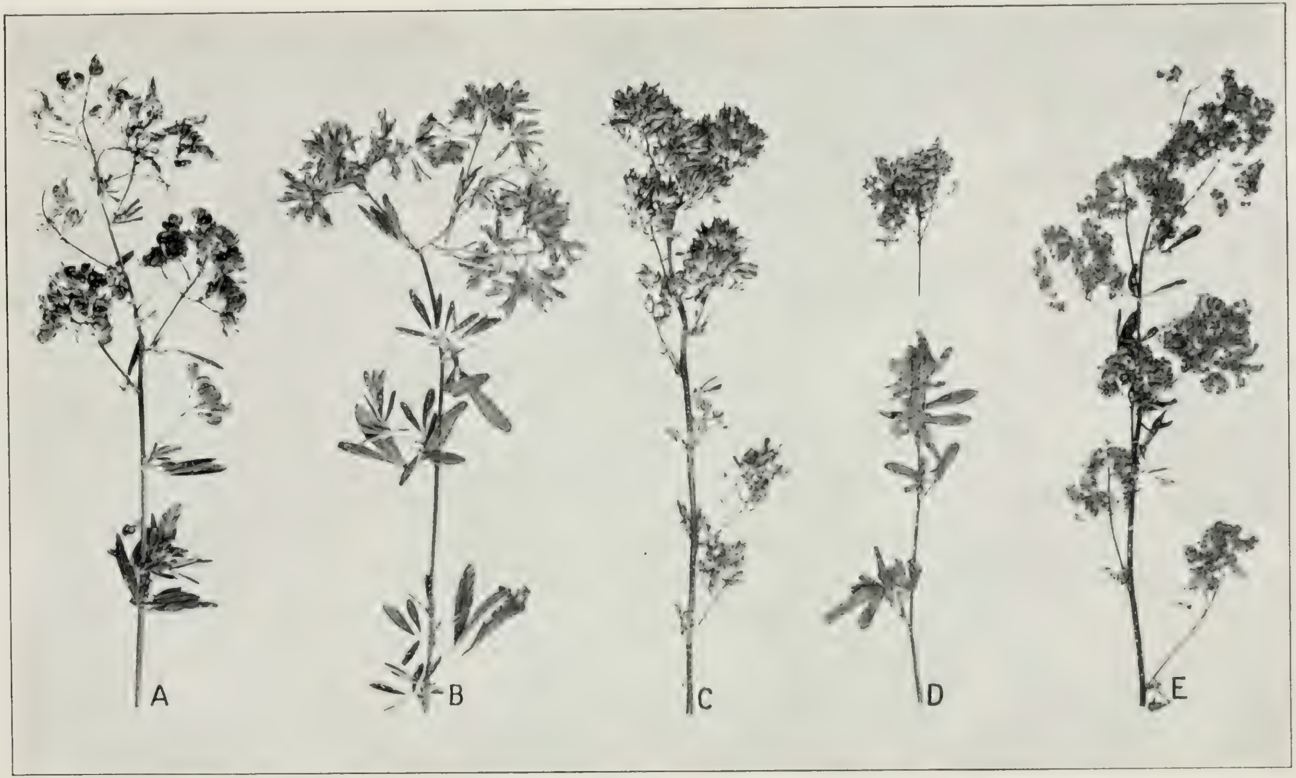


FIG. 2.—CULTIVATED ROWS OF COMMERCIAL SAND LUCERN (AT THE RIGHT) AND OF BROTT'S DRY-LAND ALFALFA (AT THE LEFT) IN THE SAME FIELD SHOWN IN FIGURE 1.



ABNORMAL INFLORESCENCES IN VARIOUS STRAINS OF VARIEGATED ALFALFA.



ABNORMAL INFLORESCENCES IN VARIOUS STRAINS OF VARIEGATED ALFALFA, IN ADDITION TO THOSE SHOWN IN PLATE VIII.

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 170.

B. T. GALLOWAY, *Chief of Bureau.*

TRACTION PLOWING.

BY

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ISSUED MARCH 12, 1910.

239495
13.1.30

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

BUREAU OF PLANT INDUSTRY.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., November 24, 1909.

Sir: I have the honor to transmit herewith a report dealing with the present status of plowing with traction engines as the motive power, by Mr. L. W. Ellis, Assistant in the Office of Farm Management of this Bureau. The economy and practicability of the use of tractors for heavy farm work rather than the mechanical features involved are discussed in this paper. I recommend that this manuscript be published as Bulletin No. 170 of the special series of this Bureau.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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ILLUSTRATION.

Fig. 1. Map of the United States, showing the approximate location of the majority of the operators of traction engines who contributed the data contained in the tables presented in this bulletin 9

B. P. I.—528.

TRACTION PLOWING.

INTRODUCTION.

For several decades, or practically ever since the development of steam traction engines for thrashing purposes, attempts have been made to use these engines instead of horses for the heavier field work, especially plowing. In the beginning failure was the result in nearly every case. The engines available were of small size, such as were only sufficiently powerful to drive a grain separator and haul it from place to place. The plows used were in the main those designed for use with animal power and were unsuitable as to both weight and construction for use with engines. When enough plows of this sort were hitched together to utilize the power such an engine was capable of developing, the outfit proved to be unwieldy, especially in turning. The transmission through light, narrow traction gearing, designed for light loads, of power sufficient for pulling this number of plows usually resulted in expensive breakage. Accidents to plows were frequent, not only because of their unsuitability, but owing to the difficulty of stopping for obstructions before damage was done. The small capacity of the makeshift outfits and the inexperience of operators were additional handicaps, and little progress was made during a long period.

Following the growth of grain farming in the West, the demand for larger and faster thrashing outfits resulted in an increase in size until engines rated at 25-horsepower came into common use. These being very powerful were supposed by many farmers to be adapted for plowing, and since they were used only a short period each year for thrashing many were fitted with plows, with little more success than in previous attempts.

Early in the last decade the field for plowing engines attracted the attention of various manufacturers, who began to remodel and design their tractors with this end in view. In addition to strengthening the gears, axles, shafting, etc., on general-purpose engines, certain companies brought out special plowing tractors, usually of greater horsepower than could be economically used except for this one operation. With the introduction of this equipment, together with plows suitable for engine plowing, the practice had a rapid extension, and instances of successful operation became more numerous as equipment was improved and skilled operators were developed.

The opening up of vast tracts of level territory where the acreage to be broken was so great as to discourage the idea of turning it with single teams and horse plows created a lively demand for steam plowing outfits, and in this field more than any other have they demonstrated their practicability. Under favorable conditions the advantages are numerous. Large areas, which otherwise would have remained uncultivated, have been brought quickly into productiveness and have been cropped with a minimum of horse and man labor, which has constantly become more expensive. Crop returns have often been greatly increased through taking advantage of favorable soil and climatic conditions for getting the land in shape for seeding, especially in sections where these conditions are of short duration. Work at such times has been rushed, often continuing day and night. At other times, as in hot, dry weather, traction outfits have been used where horses could stand the work but a short period, if at all. Through concentration of power it has been possible to plow very difficult soils and to plow deeply, when desired, in ordinary soils.

Under favorable conditions the cost of traction plowing has been brought below that of horse plowing. Considering the total cost of prime mover, shelter, and incidental equipment, and the surplus of horses needed to keep a given number in the field, the investment in motive power is frequently reduced by the substitution of engines for horses in plowing, and maintenance during periods of idleness is greatly simplified. These factors and the possibility of obtaining greater service from thrashing engines have firmly established the practice of steam plowing in sections which by reason of topography, fuel and water convenience, and state of settlement are adapted to it.

The desire for economical motors in smaller units, together with the scarcity and high price of labor and the limited supply of coal and water in some localities, has created a demand for internal-combustion tractors which has kept in advance of their development. The first gasoline traction engine to be used successfully was put on the market about 1903. Since that time numerous other companies have entered this field with greater or less success, and many of the steam-engine manufacturers are now developing internal-combustion engines as well. The gasoline tractors are being used in the same localities and for the same work as the steam engines, and a few are being built in sizes approximately as large. They have been built also in small and medium sized units and are being introduced rapidly into sections to which large steam engines were not adapted.

GEOGRAPHICAL DISTRIBUTION OF TRACTION-PLOWING OUTFITS.

Traction plowing has reached its greatest development in the newer agricultural regions where land is level and held in large tracts. The accompanying map (fig. 1) shows the location of the operators of direct traction outfits who answered in detail a circular letter bearing on this subject sent out by the Office of Farm Management. In a general way, their number and distribution are representative of the whole number, though some sections are not properly represented, and it is estimated that the number shown is not more than 2½ per cent of the total operating in 1908. A considerable number of outfits are to be found in the valleys in Utah, Wyoming, Montana, and Idaho; also in certain favorable sections of New Mexico and of various Middle and Southern States, while much larger numbers than are indicated are to be found on the Pacific coast. East of the Missouri River and the Dakotas the outfits are well scattered. The conditions in the Canadian provinces of Manitoba, Alberta, and Saskatchewan resemble those in the Northwestern States, and a large number of outfits are found there. Some of the information derived from Canadian operators is included in the tables presented later in this bulletin.

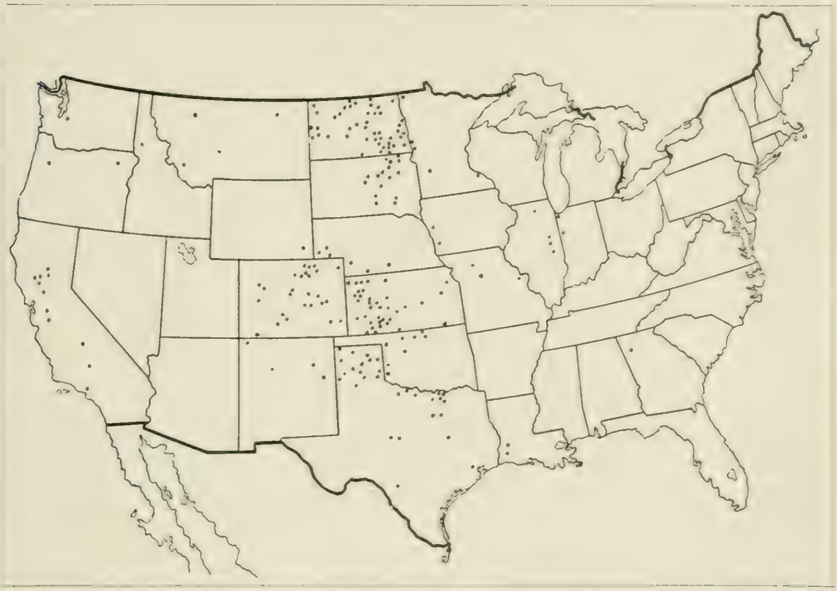

FIG. 1. Map of the United States, showing the approximate location of the majority of the operators of traction engines who contributed the data contained in the tables presented in this bulletin. The total number of outfits on which data were secured is over 500, located in the United States and Canada. Many operators furnished only partial information.

PRINCIPAL TRACTION-PLOWING SECTIONS.

As will be noted from the map, three fairly distinct sections are to be found where traction plowing is common, namely, the Pacific Coast States; the Northwestern States, including North Dakota, South Dakota, and Minnesota; and the Southwestern States, including Kansas, Colorado, Oklahoma, and Texas. Within each section conditions are similar, but between the different sections considerable variation in practice is to be attributed to differences in natural conditions.

In the Northwestern States and in Canada much prairie sod remains to be broken and the land is held in large open tracts. Grades seldom are objectionable and the natural difficulties are chiefly wet weather, soft ground, hidden rocks, and pot holes or buffalo wallows. In some sections brush or scrub is a handicap. A low quality of coal is found underlying parts of this region and is occasionally used for fuel. The coal shipped in is of the usual quality, but becomes very expensive in some places. Straw, either loose or baled, is used for fuel to a large extent during the fall, though not so convenient as coal or wood. By plowing stubble land in the autumn dry footing is obtained, and the frost tends to loosen up any soil which may have been packed by the weight of the engine. Sod land is commonly plowed rather shallow in the spring and frequently backset in the fall. Moldboard plows are used almost exclusively both for "breaking" and on old land, as disk plows leave the sod in such shape that it disintegrates slowly. "Breaking" in this connection refers to the turning of wild sod. The farms in the Dakotas and Minnesota on which steam and the larger gasoline outfits are reported average 825 acres in size, 510 acres being in harvested crops.

Traction plowing is more common in the western part of Kansas and Nebraska than in the eastern part, where corn-belt conditions are found. Throughout parts of these States and in Colorado, New Mexico, Oklahoma, and Texas level land and large tracts make plowing outfits desirable. The lack of rainfall throughout a large portion of the year makes the ground dry and hard, and horse plowing at such times is practically impossible. In wet weather the advantage is reversed, but the season for traction-plowing outfits is of such duration as to enable a large acreage to be turned. Disk plows will penetrate the dry ground better than moldboard plows and permit of a longer plowing season; hence, they are used by the great majority of operators. In Colorado the moldboard plows are used quite largely for breaking alfalfa sod. In sage-brush prairie in this State breaking is unusually difficult, being reflected in reduced acreage and a higher plowing rate. Outfits reported from the Southwest are distributed about equally among farms under a half section, from a half section to a section, from one to two sections, and over two sections, 10 per cent being over four sections.

Semiarid conditions in both the southwestern and the northwestern regions foster the demand for a gasoline engine of large capacity, both on account of the labor problem and of the difficulty of obtaining either quantity or quality of water.

In California conditions are essentially different from those east of the mountains. Grain ranches are on a larger scale and employ larger units of equipment. Custom plowing is a minor item, the larger ranches furnishing work to the entire capacity of one or more outfits. The steam plow is a natural adjunct of the steam combined harvester and is frequently used with the latter to handle the crops, with the assistance of only such teams as are needed to haul supplies. The ground is in the best state for seeding for a short time only, and during this period every possible advantage is taken of the capacity of the big steam outfits. California-built plows of light draft but capable of covering large areas are popular, and the isolation of the State with respect to eastern manufacturers has contributed to the adoption of equipment designed and built by local concerns.

The South and the corn belt are not adapted to plowing with the large steam outfits now in use on account of the small fields, the lack of custom work, and the low price per acre to be had for custom plowing. A large part of the plowing in these sections must necessarily be done in the winter and spring after the late crops are harvested, and the heavy engines are not adapted for work on old land where much moisture is present. Moreover, there is little inducement for farmers in these sections to invest in a large plowing equipment where horses must be maintained without practical reduction in numbers for cultivating the crop. The development of gasoline tractors of comparatively low weight, price, and horsepower, which can be used in the fields to supplement the work of horses and elsewhere for a variety of purposes, seems likely to prove economical not only from the standpoint of investment and cost of operation and maintenance, but from that of increased returns through the application at times when it is urgently needed of power not ordinarily available.

Throughout the Eastern States small fields and heavy grades generally prove prohibitive to the use of even the smaller motors.

EQUIPMENT FOR TRACTION PLOWING.

The equipment for traction plowing varies according to location, natural conditions, and preference. The standard types may be considered under three heads: (1) Plows, (2) prime mover or engine, and (3) miscellaneous equipment, including all conveniences for the transportation of supplies, the repair of equipment, and the care and comfort of the crew. Harrows, rollers, and other tillage implements, which are frequently drawn in connection with the plows, may also be considered under the last head.

PLOWS USED WITH ENGINES.

Practically all traction plowing is now done with specially designed engine gang plows. These may be divided into the disk and moldboard types, and the latter into steam-lift and hand-lift. Engine gangs present greater variation in type and adaptability than do engines, and this is an important factor in such success as the practice of traction plowing has had. Variations in plow shapes, such as have been worked out for local conditions, apply as well to engine as to horse plows; hence the problem has been principally to combine plow units into large gangs in the most satisfactory manner.

DISK PLOWS.

Disk plows are popular with traction plowmen, as it is possible with them to cover more ground with a given expenditure of time and power than with moldboard plows. Furthermore, it is possible with them to plow a continuous furrow around a field without labor and loss of time in lifting plows at corners or headlands, though in this case the corners are usually left to be plowed out with horses. Disk plows, especially the smaller gangs, accommodate themselves readily to uneven surfaces and tend to roll over obstructions. They can be used under certain conditions where moldboard plows can not; yet it is doubtful whether, on the whole, they do as good work. They are usually hitched to the engine by means of cables or chains, and the matter of hitching has given rise to serious problems. It was found difficult to turn corners with all plows in the ground when small gangs were used; hence, the number of disks per gang was increased until ten, twelve, and even sixteen were hung on a single frame. Besides being extremely heavy to lift, the large gangs proved to be unwieldy and hard to keep in line. The resistance of all the disks was thrown upon the rear wheel, tending to crowd the gang to the left and making it necessary to weight the rear of the gang heavily to keep the plows in the ground. Balancing the hitch by placing it near the front of the gang transferred the difficulty to the guiding of the engine, since the center of the draft was not in the center of the drawbar. Gradually the five, six, and seven disk gangs, which have proved more successful than either extreme, were evolved.

Ordinary disks are 24 inches in diameter, though larger sizes are frequently bought, especially in sandy regions, where wear is rapid. From ten to fifteen disks is a medium load for the majority of gasoline engines, and from fifteen to twenty-eight for steam engines, varying, of course, with the horsepower of the engines, the condition of the soil, the width of the cut per disk, the depth, and whether or not harrows follow the plows. These plows cost from $125 to $175 for a medium-sized gang east of the Rocky Mountains and somewhat more on the Pacific coast, where the cost of a disk-plow equipment would range in most cases from $250 to $600.

MOLDBOARD PLOWS.

Moldboard engine gangs were developed in response to the demand for a more compact arrangement than was possible with horse plows, and large gangs followed naturally. Since these had to be raised and lowered frequently, gangs of three to six bottoms prevailed until the advent of steam-lift plows. These in reality consist of several gangs of four to six plows hung on a single frame, each gang being lifted and dropped by means of a cylinder supplied with steam from the engine. Plows of this type usually contain eight, ten, or twelve 14-inch bottoms, though larger sizes are built for special soils. Compactness and the possibility of backing and turning in close quarters have made the steam-lift plow popular, though the first cost is greater, ranging from $900 to $1,500 for ordinary-sized gangs.

Types of hand-lift plows embodying the size and compactness of the steam-lift plow consist of a frame to the rear of which the bottoms are attached. In both this and the steam-lift types flexibility is secured by making the bottoms vertically independent of each other or by combining them in pairs. Irregularities in ground surface are thus met and in case of a solid obstruction one or two bottoms may be released without damage to the whole outfit. In this type of hand-lift plow each bottom or pair of bottoms is raised and lowered by a lever, from six to fourteen being mounted on the frame.

The cost of these plows is considerably less than that of the steam-lift type, ranging from $500 to $900, but as a rule the latter can be operated with one man less to the outfit.

The smaller moldboard engine gangs usually contain from three to seven plows, the 14-inch bottom being practically universal. The frame is much heavier than in the case of horse plows and the cost per bottom greater, ranging, within reasonable distance from the factory, from $100 for three furrows to from $200 to $250 for six. In some types, especially in small gangs, the plow bottoms are held rigidly, but in the larger gangs the tendency is to give each plow a certain freedom, as in the case of the steam-lift type. At present six to eight bottoms for gasoline and twelve to fourteen for steam engines are maximum sustained loads for most conditions.

A cheap and fairly effective modification of the moldboard plow known as the Stockton gang is used widely on large ranches in California. This consists of a triangular frame holding on a rigid standard from three to eight reversible plow shapes cutting 8 to 10 inches each. It is adapted to shallow plowing, stirring rather than turning the soil, and with the large engines used in that section a great acreage can be covered in a day, a strip 30 to 40 feet wide being not uncommon.

ENGINES.

The prime movers used for plowing are mainly of two types: (1) The ordinary steam traction engine and (2) the internal-combustion engine using a liquid fuel, such as gasoline, kerosene, or distillate, and commonly spoken of as a gasoline engine. Since the conditions surrounding their operation are essentially different, these two types will be taken up separately and discussed in connection with the results obtained from the use of each.

Steam engines are much more common than gasoline engines as factors in traction plowing. The variations in mechanical detail are numerous, though as a class these engines are more nearly standard than the gasoline tractors. The principal variations are in type of boiler, cylinder arrangement, and mounting. The horizontal boiler is found in the majority of engines, with either direct or return flue arrangement. In the former, which is most common, the products of combustion pass directly from the fire box through the flues to the front of the boiler and the smokestack. In the latter the gases pass to the front of the boiler through a large flue, returning through smaller tubes to a stack at the rear of the boiler.

All ordinary arrangements of cylinders are to be found on leading plowing engines. These include single and double cylinders, not compounded, and compound engines, in which steam is admitted first to a small cylinder and partially expanded and then to a larger cylinder where advantage is taken of its further expansion, both cylinders thus working through a shorter range of temperature. The arrangement of compound cylinders gives rise to the terms "tandem" and "cross-compound," signifying cylinders placed one ahead of the other and side by side, respectively. Some cross-compound engines may be converted at will into double simple engines, thus gaining additional power, as for starting a load, at a sacrifice of economy.

In most cases the driving mechanism is mounted on the boiler, though occasionally built upon a frame entirely separate. Where these parts are beneath the boiler they are said to be "undermounted." The same term is used to describe a tractor in which the main axle extends under the boiler, ahead of the fire box. Frequently the traction wheels revolve on bracket axles bolted to the sides of the fire box. This is termed "side mounting." A very satisfactory axle position is in the rear mounting, in which continuous axles are fastened to the rear of the boiler. The ideal arrangement for a plowing engine is a driving mechanism supported entirely without strain on either boiler or fire box, yet fully protected from the clouds of dust which arise in plowing.

All plowing engines are equipped with wide drive wheels to prevent miring in soft ground and loss of power through slippage. The traction gearing is wider than on thrashing engines, and is usually of steel or semisteel. Bunkers for several hours' coal supply and tanks for from one to three hours' water supply are provided, though in plowing it is usually necessary to take supplies about once an hour.

To withstand the strain and secure tractive efficiency these engines are of great weight, ranging from 7 to 20 tons. In the largest engines some reduction in weight and gain in strength are effected by substituting steel for cast iron. Throughout the entire construction emphasis is placed upon resistance to the tremendous strain of a heavy dead load on the drawbar.

Steam engines used for plowing are usually rated at from 20 to 50 tractive horsepower, most of them being between 25 and 35 horsepower. This is an arbitrary rating, placed near the efficiency of the engines as compared with horses, and much below the actual horsepower as measured by a brake test. The latter measures the power available for driving stationary machinery. It must be remembered that the power of a horse is measured in effective pull, while the engine will do many more foot-pounds of work per unit of time while standing still than when moving. Much of the power developed is used in moving the tractor and some is lost in transmission, while a reserve must be maintained for such emergencies as the horse can overcome by exerting for a short time as high as four or five times his normal efficiency. It is true that under like conditions a certain increase in power may be had of a steam engine, but to discourage overloading on the start and accidents in case of sudden obstacles the rating is usually placed at from one-fourth to one-third the brake horsepower. No general rule is followed. Both tractive and brake ratings should be known in connection with a general-purpose engine and should be placed at the point of maximum durable load rather than at the absolute maximum which can be sustained for a short period.

The cost of these engines varies with the locality and terms of purchase. Net factory prices quoted by manufacturers in the Middle West range from \$1,500 to \$3,000 for the sizes just mentioned. On the Pacific coast the common type of engine is larger, rating at 60 tractive and 110 brake horsepower, and selling, fully equipped, at from \$5,000 to \$6,000, according to terms and equipment.

MISCELLANEOUS EQUIPMENT.

In addition to engines and plows, miscellaneous equipment requiring the expenditure of a considerable sum is necessary in operating a steam outfit. There must usually be at least one coal wagon of the ordinary farm type, costing probably $75, and a second, called the "trap" wagon, for carrying repair parts, tools, and odds and ends. The tank wagon, with either a steel or wooden tank holding 10 to 16 barrels, is usually purchased with the engine, its price being included. Purchased separately it will cost from $75 to $200. A drag harrow, disk harrow, roller, crusher, or planker is usually a part of the outfit. Blacksmithing and miscellaneous tools cost from $20 to $50. In a few cases, where water is near the surface, permanent wells are sunk at convenient intervals and a small gasoline engine used for pumping. Quite often the custom operator carries an engine and attaches it to the farmer's well rather than depend on wind power. For plowing at a distance from headquarters, either a tent or cook shack, the latter on wheels, is advisable, as with this equipment the crew loses no time in going to meals during the day or to the engine in firing up in the morning. The shack, complete, will cost from $200 to $300 as a rule, and occasionally $500. Teams will add to the investment, but are for convenience included as a part of the labor cost of operating. As an average first cost of miscellaneous equipment for steam-plowing outfits $500 is estimated.

FACTORS AFFECTING THE ECONOMY OF OPERATION OF STEAM OUTFITS.

The factors entering into the economy of either steam or gasoline plowing include not only those concerning the operation of equipment, but those arising from the effect of the practice upon the management of the individual farm and upon the agriculture of a section. The latter have been outlined somewhat in the introductory paragraphs, but owing to the nature of the problem this investigation has been confined chiefly to study of the cost of operation, the factors governing which are more clearly defined. The essential factors are so many and so varied that certain ones may easily be overlooked; hence, they will be discussed in some detail.

COST OF OPERATION.

The actual cost of operation includes not only the cash outlay for labor, fuel, oil, repairs, etc., but the interest and depreciation on equipment. The figures presented in this connection are not to be taken as final, because (1) very few operators keep accurate accounts, (2) depreciation and repair charges must be based almost entirely on estimates, only a small proportion of plowing outfits having actually been worn out, and (3) with the improvement in equipment and with the education of operators the efficiency of outfits must be gradually increased. Detailed estimates of the cost of plowing are given by sections.

OVERHEAD CHARGES.

Among the factors in the cost of plowing which are very often disregarded by operators who have not had a business training are the overhead charges, which include interest on the money invested and the depreciation of the outfit. If the outfit is bought on time the matter of interest is necessarily brought to the owner's attention. However, it is a frequent practice among owners who have paid cash to allow nothing for interest on their capital, thus apparently increasing the net profits from their work when as a matter of fact the venture may not be paying as good a rate of interest as might have been obtained by depositing the capital in an ordinary savings bank. Seven or 8 per cent interest is a common rate on machinery notes in the sections where traction plowing is most common.

The matter of depreciation is probably even less considered by the average operator than that of interest. Depreciation charges should be made in order that at the expiration of the life of the outfit a sufficient amount shall have been set aside either to replace the outfit in its original condition or to restore to the owner his original capital. The rate of depreciation depends, of course, upon the wear and tear on an outfit during a given period of use, or, in other words, upon the life of the outfit. The practice of traction plowing is so new that the average life of plowing engines can not be accurately determined, and the rapid improvements in equipment make of little value such figures as are obtainable from outfits already partially worn out. The life of plowing engines depends not only on the care given and the amount of work done, but upon natural conditions, such as climate, soil, topography, and in the case of steam engines the water used in the boilers. The soil in particular, with respect to its resistance, uniformity, and grittiness, exerts a great influence on the life and repairs of both engines and plows.

Manufacturers of steam outfits vary in their estimates of the life of plowing engines from four and one-half years when given maximum use to twenty years for ordinary use with excellent care. The general opinion of the manufacturers ranges between eight and twelve years, converging at ten. The factor of use per year must be taken into consideration. In California eleven owners of large steam engines plowing nearly 3,500 acres per year each make an average estimate of fifteen years. Thirty out of seventy-six correspondents in the Southwest estimate ten years as the life of their engines, the average of the whole number being 10.04 years. The average acreage per year reported from these operators is 1,075. In the Northwest and Canada thirty-two out of eighty-five operators estimate 10 years, and the average estimate is 10.7 years. Their average acreage per year is 797. Taking the two sections together and considering, as before, only those operators who state the annual acreage and the estimated life, sixty-two out of one hundred and sixty-one agree on ten years, the average being 10.4 years, while the average area plowed per year is 903 acres.

The consensus of opinion regarding the life of engines used in plowing and thrashing might fairly be taken as a basis for estimating the rate of depreciation, but closer inquiry in the field reveals the fact that while many engines of the type now being put out will have a life of ten years the majority of operators do not expect ten years' service in plowing. A great many place the plowing service at from four to six years, after which, when equipped with new gears and generally rebuilt, the engines are fit for service in thrashing as long as the boiler lasts, which may easily reach a like period thereafter. For this reason it is probable that the majority of correspondents who placed the life of their plowing engines at ten or more years misunderstood the question asked in the circular letter sent out by the Office of Farm Management. After duly considering all the data and estimates regarding the life of plowing engines, a rate of 10 per cent of the first cost of the engine is taken as the value consumed annually *in plowing alone* during the first five years of the life of the outfit.

Since approximately 90 per cent of the engines reported as plowing are used also for other purposes—principally thrashing—and an average of reports indicates approximately equal periods of plowing and thrashing, a division of the interest and depreciation charges on the basis of comparative wear and tear becomes necessary. The wear and strain on engines in the two operations is essentially different, being heaviest on different parts during each. When thrashing, the wear is mainly on the engine parts, and in plowing on both the engine parts and the traction gearing. The wear in plowing has been variously estimated at from two to ten times that in thrashing. The opinion of several of the leading manufacturers and other authorities centers about 75 per cent of the total wear as chargeable to plowing, as compared to 25 per cent for thrashing during equal periods of service. Since the reports from operators indicate practically the same number of days' plowing and thrashing each year, these figures are taken as the basis for dividing the overhead charges. Repairs might be included under this head, since they can be divided on this basis, but it has been considered more appropriate to include them under running expenses.

Following the method outlined of calculating and dividing the overhead charges, the division on an engine costing \$3,000 would be, for the first five years, at the rate of 10 per cent depreciation and 5¼ per cent interest for plowing, 3⅓ per cent depreciation and 1¾ per cent interest for thrashing. With regard to the calculation of interest, however, the average investment during each five-year period must be ascertained. Granting the approximate correctness of the preceding assumption, it is seen that the total rate of depreciation of the engine will be \$400 a year and at the end of the fifth season the value will have been reduced to \$1,000. As interest is taken on the value of the engine at the beginning of each season, the average value during the five seasons is seen to be \$2,200. Interest at 7 per cent, therefore, would be \$154 each year, or \$115.50 for plowing and \$38.50 for thrashing. Depreciation during the same time would be \$300 and \$100, respectively. During the last five years of the life of the engine both interest and depreciation would be chargeable to thrashing, the former at the rate of 7 per cent on an average valuation of \$600 and the latter at an average rate of \$200. As a matter of fact, the establishment of depreciation charges must be largely theoretical even in the most carefully conducted manufacturing or transportation enterprises, but the matter is one which should be carefully figured upon by every operator. Few traction engines are ever actually worn out; hence, the values are seldom reduced to a practical zero. Without extended investigation, which it is hoped may be undertaken, accurate figures covering the entire life of traction engines are not to be had, but without such figures from a considerable number of operators the estimates given are as likely to indicate the truth as any which might be made.

With regard to the life of plows and minor equipment, no data are at hand and depreciation is charged arbitrarily at 10 per cent. Plow depreciation is of course wholly chargeable to plowing, but that of miscellaneous equipment, being due to practically equal use in plowing and thrashing, is charged equally to both.

REPAIRS, OIL, ETC.

As previously stated, the division of repairs may be made on the same basis as that of overhead charges. From such data as are at hand, together with estimates from men in a position to have considerable knowledge on this point, it is possible to arrive in two ways at the cost of repairs per acre plowed. The average cost of repairs per year is estimated by several authorities at \$100, of which \$75 would be chargeable to plowing. Other authorities estimate the cost of engine repairs per acre at from 6 to 10 cents, and data from those operators who reported on this point indicate the latter figure as close to the average. It may be, however, that their figures covered the cost of repairs chargeable to thrashing and that an estimate of 10 cents per acre for engine repairs would probably cover the cost of keeping the majority of engines in good condition for work. Plow repairs are estimated at from 75 cents to $2 for each working day, including the expense of sharpening. The latter is much greater in the case of moldboard plows than with disk plows; hence, in estimating the cost of plowing, a larger figure per acre is allowed in the Northwest than in the Southwest.

In addition to expenses for repairs, labor, fuel, etc., from 2 to 5 cents per acre must be allowed for various lubricants, including crude oil for traction gearings, engine and cylinder oil, grease, and hard oil.

LABOR.

From three to six men are needed in operating a steam-plowing outfit. One guides, and a second usually fires the engine. One of these frequently looks after the plows. A third man and team supply the engine with water and fuel, and two men with teams are needed if supplies are to be hauled any great distance. Frequently one man gives his entire time to the plows, while a cook is needed in many cases. The engineer is naturally the best paid, receiving, according to correspondents, an average of $3.12 per day in the southwest group of States, $4.43 in the northwest group, and $4.30 in California. The guider's wage is more uniform, averaging $1.88. The plowman and teamsters are paid from $1.50 to $1.75 in most cases, the former having a slight advantage, while $1 is the common figure for the cook. In many cases it would be economy to pay much higher wages for the engineer, at least, as good management and efficient help tend to reduce delays through accidents or other causes. Board at 50 cents a day for each man and 75 cents for the use and board of each horse are usually to be added to wages in arriving at the labor cost. The majority of operators furnish board, many boarding but not paying the men on idle days. In estimating the labor cost per acre in this bulletin no account has been taken of wages, board, and keep of teams on idle days, but this amount, if it could be ascertained, should be added to the total. It is doubtful whether, on the average, steam-plowing outfits are able to work more than two days out of three during the plowing season, owing to accidents, moving, bad weather, and other causes.

The average daily cost of fuel, as gathered from operators, is given elsewhere under estimates of the cost of plowing. The quantity and cost per acre vary with the locality, the kind and cost of fuel, the acreage plowed per day, the condition of the soil, the construction of the engine, the efficiency of the operator, and perhaps other factors.

Coal is most used in steam tractors, though wood is used to a limited extent, and straw in some sections. Crude oil is used extensively in California.

WATER.

In steam plowing the quality and proximity of water are important factors. As the daily consumption ranges from 1,500 to 5,000 gallons, the labor involved is considerable, and is much increased with the hauling distance. Muddy or alkali water by depositing a sediment in the boiler reduces the evaporation per pound of coal consumed, necessitates frequent washing of the boiler, and causes rapid depreciation of the flues. Some boilers will evaporate a greater quantity of water per pound of fuel than others, thus producing steam more economically, but frequently the poor handling of an engine will cause the waste of a large quantity of water. From the averages shown in Table II on page 25 it will be seen that the water used per pound of coal is 7.49 pounds in the Southwest and 7.74 pounds in the Northwest. In California it is approximately 9.4 gallons of water per gallon of oil.

PLOWING CAPACITY OF TRACTION OUTFITS.

Certain factors governing the average acreage plowed daily or yearly have already been mentioned. This acreage is the output of the plowing equipment and crew, and in great measure it represents the success of the venture. It is the product of distance traveled in plowing and the width of the cut of the plows. The latter is governed largely by the power of the engine and by the soil conditions, but the former is influenced by a multitude of circumstances. The reports from 220 operators indicate an average working day for steam outfits of 11.27 hours, and the various engines have speeds ranging from 2 to 3 miles an hour. The average cut of moldboard plows in the Northwest is ascertained to be 11.18 feet, and of disk plows in the Southwest 13.2 feet. At 2.5 miles an hour the theoretical daily capacity of moldboard plows would be about 38 acres, and of disks about 45 acres. The daily average for the Northwest, using moldboard plows almost exclusively, is approximately 22.9 acres, and for the Southwest, using disk plows principally, 25.7 acres; hence, the actual performance is much lower than the theoretical capacity of outfits. Much of this loss is unavoidable, due to slippage of traction wheels and to time spent in turning and in taking on supplies. In the latter operation alone the loss of time may easily reach 25 per cent. Observation of steam outfits in the field shows that the time spent in taking on supplies varies with the crew and amounts to from five to fifteen minutes out of each hour. The importance of getting the greatest service out of the equipment is not always appreciated, especially by hired crews.

The tendency frequently is to attempt to secure high acreage by running at a high speed or by overloading the engine. The latter evil is the more common, the temptation to add an extra plow or a load of harrows often being too strong to resist. The effects of exceeding the maximum durable speed or load are to be seen in increased wear and breakage, with consequent delay, which overcomes any advantage gained by crowding the outfit. The reports received from operators do not distinguish clearly as regards performance between sod breaking and stubble plowing. Taking the data as a whole, it is found that approximately two-thirds of all operators harrow, disk, or roll the ground while plowing. The percentage is higher in the Southwest than in the Northwest, and in most cases somewhat greater power is used for this extra work, owing to the wider cut of plows. Of steam outfits 54 per cent and 27 per cent of one make of gasoline outfits reporting from the Northwest do other work while plowing, and 10 per cent and 3 per cent, respectively, of the total cost shown elsewhere may be charged to this extra work, basing the division on proportionate power consumption. Practically all these outfits use moldboard plows. The average nominal or tractive horsepower used in pulling plows only is 2.23 per foot cut for steam engines and 2.69 for gasoline engines. Therefore, 2.6 horsepower and 3.14 horsepower, nominal rating, are left, respectively, for each 14-inch plow bottom, after deducting the power used in pulling harrows, etc. In the Southwest 13 per cent of the power of the average steam outfit reported and 11 per cent of that of the average gasoline outfit reported are shown to be chargeable to work other than plowing. Of the steam outfits 70 per cent and of the gasoline outfits 80 per cent report extra work. After deducting the power thus consumed, 1.75 nominal horsepower per foot cut is expended by the steam outfits in pulling plows and 2.22 horsepower by gasoline outfits. This is based on the average width of furrow cut by the disk-plow outfits, as shown in Table II. From 8 to 10 inches is the usual cut per disk. From this it would appear that two or more plows should be dropped if harrowing is done, depending on the draft of the extra load, and that 10 moldboard or 15 to 20 disk plows are a load for the average steam engine, while the type of gasoline engine mentioned can handle fewer plows than steam engines of equal nominal rating. From 30 to 50 per cent more acres can usually be covered each day in stubble plowing than in breaking virgin sod, and the coal consumption to the acre averages less, though probably not in the same ratio. Sod breaking is usually shallower, and the heavier draft is overcome somewhat by the increased efficiency of the engine on the firm footing afforded by the sod.

In rush seasons night plowing is occasionally resorted to, as well as the use of two shifts between early dawn and late twilight. The latter is the simpler and more satisfactory method, but the difficulty of securing two efficient crews and the division of responsibility for accidents tend in either case to offset the doubling of the capacity.

Large daily acreages can not be secured in small fields, and few operators care to bother with jobs of less than 25 to 40 acres. Short furrows and frequent turns involve loss of time and a poorer quality of work. In fenced fields it is difficult to plow out corners by traction without special care and equipment, and frequently horses are employed for this purpose. This and the expense attached to moving make small jobs unprofitable. Forethought in attacking fields will reduce the area left unplowed by traction, and the manufacturers usually offer suggestions as to time-saving methods of laying out lands. The yearly acreage is influenced by all the foregoing factors of daily operation, also by the seasonal conditions, delays from disabling accidents, the amount of work to be had, and competition.

INCOME FROM TRACTION-PLOWING OUTFITS.

The apparent profit in steam plowing is so great as to encourage the reckless buying of equipment. From 30 to 40 acres is not an uncommon day's work and the mere running expense is often below $20. At prices ranging from $1.50 to $4 to the acre the daily income is apparently much in excess of operating expense, the factors of interest, depreciation, expense during idleness, and cost of moving often being overlooked. Keen competition is developed in some communities and the rate for custom plowing reduced to the point where only the most successful can make a profit. A study of the data given later as to the acreage plowed annually will show that, except in California, where holdings are much larger, the custom acreage is nearly or more than equal to the area plowed for the owner of the outfit. It follows, then, that even with all other factors favorable, financial success is doubtful where the custom rate is low.

The following table shows the range and average of custom prices, as reported by operators of both steam and gasoline outfits:

Table I.—*Prices charged for traction plowing in fifteen States and in Canada.*

Location of outfits.	Number of operators reporting.	Prices charged for plowing.		
		Lowest.	Highest.	Average.
North Dakota, South Dakota, Minnesota, and Montana	73	$1.25	$4.00	$2.99
Nebraska, Colorado, Kansas, Oklahoma, Texas, and New Mexico	116	.75	3.50	1.88
Indiana, Illinois, Iowa, and Missouri	6	1.00	2.00	1.44
California	12	1.25	1.60	1.32
Canada	23	1.75	5.00	3.66

The lowest figures are usually for stubble plowing and the highest for breaking sod, but the rates charged by the same operator for the two kinds of work are not as far apart as the range indicated. In parts of Kansas a difference of only 25 cents an acre is made, and a difference of 50 cents is reported by more operators in both Plains sections than any other figure. A difference of $1 or more is, however, common in the Northwest. In some cases these prices cover both plowing and harrowing, while in others from 10 to 25 cents an acre are added for harrowing. The prices in the corn belt and in Kansas, Oklahoma, and Texas (the average being $1.50 in Kansas and $1.62 for the three States) are so low as to leave little or no margin to cover expenses during idleness and net a profit. With all other factors equal, a slight increase in the rate will often turn an unsuccessful venture into a profitable one.

AVERAGE RESULTS WITH STEAM-PLOWING OUTFITS.

In view of the extreme variation in conditions encountered by individual operators, any averages of results must be taken with due regard for local conditions. The following table presents a summary of the data taken from reports complete enough to give the desired information. These include results for a part of the season of 1908. For the purpose of comparison, two columns are shown for Canada. The first is from direct reports from operators. In the second column averages are taken from the annual traction-plowing numbers of "The Canadian Thresherman and Farmer," from 1905 to 1909, inclusive, and represent 214 letters of steam plowmen in answer to that journal's annual circular letters on this subject. A small percentage of the letters are duplicated; that is, they are from the same operator in different years, and several correspondents reporting under column 1 are also found under column 2. The average of coal used given in column 2 is from 150 operators, many using either wood or straw or not reporting at all. Those using wood report about 2 cords a day as an average. The average number of barrels of water used by Canadian operators apparently varies greatly. However, a difference in standards may explain the variation. If the 72.8 barrels in column 1 were of 31.5 imperial gallons of 10 pounds each and the 57.1 barrels in column 2 were of 42 imperial gallons the water used per pound of coal would be 7.21 and 7.82 pounds, respectively. It is difficult otherwise to account for such a wide variation.

TABLE II.—*Data in reference to steam-plowing outfits operated in California, in the southwestern and the northwestern sections of the United States, and in Canada.*

Work accomplished, etc.	California.	Southwest.	Northwest.	Canada.	
				1.	2.
Number reporting	11	100	60	23	214
Acres plowed annually for self	2,800	475	310	379	....
Acres plowed annually for others	689	580	348	628	....
Acres plowed annually, total	3,489	1,055	658	1,007	....
Percentage of custom plowing	20	55	53	61	....
Size of engine (horsepower)	[a] 110	26.46	27.5	29	27.28
Cost of engine	$5,500	$2,680	$2,505	$3,420	....
Number of plows[b]	23.3	....	9.58	11	8.6
Width of furrow cut (feet)[b]	20.45	12.8	11.18	12.83	10.03
Cost of plows[b]	$506	$451	$657	$860	....
Hours of work each day	10.6	11	11.44	12.31	....
Miles covered each day[c]	20.4	16.4	16.9	13.8	16.75
Acres covered each day	50.6	25.7	22.9	21.4	20.37
Days of plowing for the year	69	41	29	47	....
Men employed	6	3.43	4.24	4.11	4.46
Horses used	5.5	3.1	4.5	3.9	3.36
Labor and board (by day)	$16.50	$11	$14	$14	....
Quantity of fuel used each day[d]	7.16	2,508	2,735	3,151	3,064
Quantity of fuel used for each acre[d]	0.14	98.4	126.6	147.4	150.4
Cost of fuel for each day	$7.28	$6.91	$8.71	$8.34	....
Cost of fuel for each acre	$0.144	$0.273	$0.38	$0.39	....
Quantity of water used each day[e]	3,367	74.1	77.75	72.8	57.1
Cost of oil, etc., for each day	$1.00	$0.57	$0.59	$0.87	....

[a] Brake horsepower. Nominal or tractive rating about 60 horsepower.

[b] Less than one-fifth of the outfits reported in the Southwest use moldboard plows. These average 9.18 bottoms, cutting 10.7 feet, and cost $561 each. From 10 to 20 disk plows would be used to cut the average of 13.2 feet reported. These sets average $428 in price. The figures in the table are for the average of both types.

[c] "Miles a day" is miles traveled with plows in the ground, as figured from the daily acreage and the average width of the furrow. The distance traveled in turning, etc., is not included.

[d] For California expressed in barrels of crude oil; elsewhere in pounds of coal.

[e] For California expressed in gallons; elsewhere in the United States in barrels of 31.5 gallons.

The data for 1907 and 1908 under column 2 are much nearer the figures contained in first-hand reports from the Northwest and Canada, as is to be expected in view of the time covered by the latter. For these two years the averages of data contained in 118 letters show the size of the engine to be 27.7 horsepower; number of plows, 9.09; width of furrow, 10.6 feet; miles a day, 16.75; acres a day, 21.52; number of men, 4.53; number of horses, 3.57; quantity of coal a day, 3,245 pounds; quantity of coal for each acre, 150.8 pounds.

COST OF PLOWING WITH STEAM ENGINES.

In the following table the acre cost of plowing is based on the data in Table II. A considerable number of other operators were interviewed, but principally with regard to points not covered in the circular letters, their experience and results being on a par with those of the correspondents. It was found impracticable to separate the cost of harrowing in each report; hence, the corrected total for plowing alone is based on the percentages given under the discussion of acreage plowed on page 22.

TABLE III.—*Acre cost of steam plowing (including harrowing, etc.) in California, in the southwestern and the northwestern sections of the United States, and in Canada.*

Details of cost.	California.	Southwest.	Northwest.	Canada.
Interest on engine	$0.069	$0.098	$0.143	$0.131
Depreciation on engine	.158	.254	.381	.34
Repairs on engine	.08	.10	.10	.10
Interest on plows	.009	.024	.056	.048
Depreciation on plows	.015	.043	.10	.085
Repairs on plows	.02	.035	.066	.07
Interest and depreciation on miscellaneous equipment	.012	.037	.059	.039
Labor and board	.326	.428	.611	.654
Fuel	.144	.269	.38	.39
Oil, grease, etc	.02	.022	.026	.041
Total	.853	1.31	1.922	1.898
Corrected total	....	1.14	1.73	....

The cost of men and teams on off days and of moving from place to place between jobs must be added to the cost per acre of plowing. This will frequently more than offset the correction for harrowing, the cost for each day of idleness being higher, of course, with steam than with gasoline outfits. The days of idleness are more frequent, possibly one in three, adding 10 to 15 cents per acre to the cost given. Since both breaking and stubble plowing are included, and in unknown proportions, no satisfactory statement can be made as to the relative cost of each. However, the daily running expenses are not essentially different; hence the relative cost is probably in inverse proportion to the daily acreage.

COMPARATIVE RESULTS WITH STEAM ENGINES OF DIFFERENT SIZES.

The following table shows fairly well what may be expected of steam engines of the small, medium, and large sizes generally used for plowing. Extremes are not represented. It will be noted that in the Southwest the medium-sized engines seem to be the most popular, and those of the largest size in the Northwest, while few small engines are used in either section. With the exception of the quantity of coal per acre in the case of small engines in the Northwest, the averages show the results that might be expected from the size of the engine, and in this case the number of operators is so small as to render the figures of little value. The number of men and horses evidently is not in proportion to the size of the engine. In both sections the small engines apparently travel more miles a day than the larger ones, this figure, as before, being calculated from the acreage plowed and the width of furrow. The figures as to horsepower per foot cut and the reciprocal "feet cut per horsepower" are quite significant, indicating that the larger engines furnish greater power per unit of nominal rating than the smaller. A comparison of sections on this point shows that from 20 to 25 per cent more power per foot of width is required in the Northwest than in the Southwest. The wider use of disk plows will account for a large part of this difference.

TABLE IV.—*Comparison of various sizes of steam-plowing engines used in the southwestern and the northwestern sections of the United States and in Canada.*

Details for steam outfits.	Southwest.			Northwest and Canada.		
	18, 20, and 22 horsepower.	25 horsepower.	30, 32, and 35 horsepower.	18, 20, and 22 horsepower.	25 horsepower.	30, 32, and 35 horsepower.
Number of outfits	10	42	22	5	21	41
Average size of engine	20.2	25	31.95	20.4	25	31.9
Width of furrow (feet)	9.15	12.25	16.67	7.5	10.23	13.2
Width of furrow (inches)	109.8	147	192	90	122.8	158.5
Men employed	3.6	3.43	3.76	3.8	3.95	4.39
Horses used	3.4	3.05	3.3	2.6	2.95	3.8
Acres covered each day	20.5	23.2	33.4	16.8	19.6	25.2
Miles covered each day	18.5	15.6	16.5	18.5	15.8	15.8
Horsepower per foot cut	2.21	2.04	1.92	2.72	2.44	2.42
Feet cut per horsepower	.452	.49	.521	.368	.409	.413
Pounds of coal used each day	2,350	2,457	3,218	1,780	2,552	3,100
Pounds of coal used for each acre	114.6	105.9	96.3	106	130.2	122.9

CABLE SYSTEM OF STEAM PLOWING.

In England, Germany, and other countries a common type of steam plowing involves the use of plows or other implements drawn by cables. A number of these outfits, all of foreign make, are used in various parts of the West, principally in California, and there chiefly on large sugar-beet ranches. So far as known, all of these outfits are of the double-engine type, a traction engine being located during operation at either side of the field. Steel cables, 80 to 100 rods long, attached to the implement, are wound on drums mounted beneath the engine boilers, the engines pulling alternately. In this way the entire power of the engines is available for work, none being used in moving their own weight across the fields. The engines advance alternately the width of the furrow, moving in parallel directions at right angles to the furrow. In many cases permanent roads along the sides of the fields insure a firm footing for the traction wheels. Balance plows are used, i. e., right and left hand moldboard plows are mounted in gangs facing a pair of large wheels. In plowing, the implement is not reversed, the forward gang being tilted out of the ground on one trip and plowing on the return. Frames to which harrows, rollers, etc., may be attached, cultivators, beet plows, and other implements for cultivation are a part of the equipment, and usually all tillage operations connected with the beet crop are accomplished without the use of animals.

Plowing is done at a depth of 12 to 14 inches for sugar beets, and in heavy adobe soil from 10 to 20 acres are covered per day. Light cultivation is done at a depth of 7 to 9 inches and deep tillage at from 14 to 16 inches, the cultivators being 16 feet and 10 feet in width, respectively. Cultivating is done at the rate of 25 to 35 acres and harrowing at the rate of 50 acres a day. A special implement, lifting 6 rows of beets at a depth of 12 to 16 inches, is used in harvesting, and from 15 to 25 acres are covered in a day when necessary. No time is lost in taking supplies, as the engines are stationary, and little time is wasted at the ends of the furrows, one engine being ready to start pulling as soon as the other finishes.

From five to eight men are used in plowing, including a foreman, two engineers, one or two teamsters, two plowmen, and a cook. From 6 to 8 barrels of crude oil daily supply both engines. The expenses, not including interest and depreciation, are about $30 a day, or from $2 to $3 an acre. In comparing this with the cost of operating direct traction outfits, the great difference in depth of plowing must be kept in mind. Interest and depreciation charges are heavy, though the outfits are in use the greater part of the year. The investment for each outfit, including freight and duty, is from $25,000 to $30,000. The cables, which cost from $600 to $900 each, last from six to eighteen months in continuous use, and bad water destroys flues in from six to twelve months; otherwise the outfits are capable of long service.

In view of the heavy initial and operating cost, the use of this equipment is restricted to large enterprises. One ranch in California uses five sets of tackle in handling 10,000 acres of sugar beets, using horses only in seeding and hauling. Each outfit is said to displace 120 horses and the necessary drivers. Another outfit, operating eleven months in the year, handles 1,300 acres of beets. Others are to be found in large vineyards, while a large number are used in sugar-cane culture in Hawaii. While these outfits are not suitable for use on a small scale it would seem that a modification, embodying numerous advantages and adapted to more general use, might be produced in the United States and sold at a price within the reach of small operators.

INTERNAL-COMBUSTION ENGINES.

Internal-combustion engines, represented by gasoline and kerosene motors, are usually of smaller size than the steam engines used for plowing. They range from 12 to 40 horsepower, nominal rating, and from 19 to 80 horsepower, brake rating. As before explained, the nominal rating is supposed to denote the equivalent of the work of the number of horses specified which is performed by the engine, while the brake rating indicates the power of the engine for belt work. In size internal-combustion engines range from a weight of a little more than 2 tons to 17 or 18 tons, although the majority in use are between 5 and 10 tons. As a rule, they are rated higher in proportion to actual brake horsepower than are steam engines, but have a higher tractive efficiency than the latter; that is, deliver a larger proportion of the total power in effective pull. The same confusion as to rating prevails and, owing to the differences in the practice of various manufacturers, gasoline engines are frequently expected to do more than their actual horsepower warrants. In price these motors are usually more expensive per brake horsepower than steam engines, the types most used ranging in cost from $1,300 to $2,500 delivered free in territory within reasonable distance from the factories.

Gasoline engines, using this term to designate all of the oil-burning internal-combustion class, present a great variation in type, having so recently been developed as to lack the standardization possessed by steam traction engines. The four-cycle motor is universally used.[a] Most of the smaller tractors are of the single-cylinder type, which is the most economical of fuel but not so steady in running as multiple-cylinder types, on account of the longer interval between power strokes. On account of the limitations to the size of cylinders this type must necessarily continue to be made in small units, the more powerful tractors now on the market using two, three, or four cylinders. These may be either vertical or horizontal, and if horizontal either "twin" or "opposed," i. e., either side by side or in line on opposite sides of the crank shaft. The larger the number of cylinders the more complicated the motor, but usually the more smooth running, owing to the more nearly continuous succession of power strokes. Two opposed pistons in a single cylinder are used on one type. The variation in engine speed is considerable, ranging from 220 to 1,600 revolutions a minute, but as a rule not over 550 revolutions are made at normal speed. Differences in the method of governing, ignition, reversing, and cooling are notable, the latter including air, water, oil, and steam cooling devices. Practically all tractors are gear driven, but great variation as to the height and width of traction wheels is found.

A few types are equipped for burning either gasoline, kerosene, or distillate (low-grade kerosene), although no motor has as yet been developed which will handle the different fuels equally well under all conditions. Distillate is largely used on the Pacific coast, but is not easily obtainable in other sections. Kerosene is used to a great extent in at least one of the leading plowing tractors. Both kerosene and distillate are cheaper by the gallon than gasoline, and reports from correspondents indicate that the fuel cost per acre is less also.

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[a] For an exposition of a four-cycle motor, see Farmers' Bulletin 277.

Alcohol is not as yet a commercially important fuel for traction engines. Opinion as to the relative merits of kerosene and gasoline is divided. The former may be used successfully where the engine is operating under a full and rather constant load, as in plowing, but owing to its heterogeneous composition it does not give such perfect combustion under varying conditions as does gasoline. As a rule, from 1 to 2 gallons of the latter are used per day for starting and warming up the kerosene motors; hence its use is seldom entirely dispensed with. The rapid development of internal-combustion engines for marine, automobile, traction, and stationary purposes has increased the demand for gasoline and the rate of exhaustion of the supply, so that it seems only a question of time when the less volatile oils will of necessity be used extensively in tractors. For the present, however, gasoline remains the standard fuel and the majority of new tractors are being designed primarily with a view to its use.

COST OF PLOWING WITH GASOLINE ENGINES.

As is the case with steam engines, the practice of using gasoline motors for plowing is so new that satisfactory figures regarding life, repairs, etc., are not to be had. It follows, therefore, that figures on the cost of plowing are not conclusive except as regards the expenses which may be designated as current. The first successful gasoline tractors were put on the market about 1903, and comparatively few have been out long enough for operators to become thoroughly familiar with what may be expected of them, yet the figures given in the following pages may be taken as indicative of their practicability.

With regard to the factors of interest and depreciation the same general points will apply to gasoline as to steam engines. It is doubtful whether the comparative wear in plowing and thrashing will be in the same proportion as with steam engines, as the gasoline engines are less likely to be overloaded in plowing. Gasoline engines when first developed were stationary and could be rated on the same basis as stationary steam engines or in comparison with horses on a small horsepower. Later on, some of these same engines were mounted on traction trucks and given the same rating as before. This naturally confused purchasers, who expected these engines to draw the same load as steam engines of equal rating. Serious disappointment to the users and damage to the tractors were the result. A few makes of gasoline tractors were given a nominal rating, based on the number of horses which they would equal in effective pull, though the various manufacturers took different bases for their ratings. Operators soon found that gasoline tractors could not be forced beyond the maximum of power developed at the time of explosion, and were not to be relied upon for getting out of serious difficulty when already pulling a full load. On this account it is probable that gasoline engines as a whole pull loads more suited to their normal and durable power than do steam engines. On the other hand, owing to the smaller margin of brake horsepower over and above the nominal rating, they are more likely to be crowded to their limit in running separators or other machines driven by belt power. A leading manufacturer of gasoline engines estimates the wear and tear at 70 and 30 per cent, respectively, for plowing and thrashing, when given equal length of service. Other authorities who have given thought to this point are of the opinion that, with the exception of such makes as have a low nominal rating in proportion to actual horsepower, gasoline engines as a class will be worn almost equally by plowing and thrashing. Taking the whole class of gasoline tractors, it is probabl that a division of wear and tear and interest on the basis of 60 and 40 per cent for the two operations will be as accurate as can be assumed at this time.

The life of gasoline tractors will at present depend very largely upon the make, owing to the large number of experimental machines which are being offered. However, since the data contained in this bulletin are taken only from those makes of tractors which have demonstrated for several seasons their practicability in the hands of a number of operators, the assumptions made in connection with the life and service of steam engines may be repeated here and the same rate of interest and depreciation taken. Estimates from a number of operators of the internal-combustion tractor now in most common use place the life of the outfit at ten years, and although this is probably in excess of the actual service the exact figures can not be determined, as practically none of the standard outfits have been abandoned on account of wearing out.

Repairs to engines are estimated at 10 cents an acre and $100 a year, respectively, by two officials of the company making the tractor just mentioned, these amounts being deemed ample to keep all parts in perfect order and recommended as being economical expenditures on the part of the purchaser. The former figure supports the estimates of several correspondents and may in this case be fairly assumed as correct. The plows used are of the same type as those employed with steam engines, though of course fewer in number, and the plow repairs will be proportionately less. The cost of miscellaneous equipment will usually be covered by $100, as provision must be made for but two men and the transportation of a comparatively small quantity of fuel and water.

The labor cost of operating gasoline outfits is usually limited to the wages and keep of two men, one for the engine and one for the plows. This is true regardless of the size or make of the tractor. Horses are used but a few hours a week, if at all. In many sections gasoline is delivered in the field by the dealer, horses thus being dispensed with entirely. Licensed engineers are not usually required with gasoline outfits, and consequently the labor rate is usually lower than with steam outfits. The cost of maintenance is of course less, and $7 a day for the wages and board of the two men required will probably cover all but a very few cases. The figure allowed for labor includes the wages of a first-class engineer, as, notwithstanding the simplicity of gasoline engines, skilled labor is as essential to the best results as with steam engines. Board is allowed at the rate of $1 per day, and a small charge for the occasional use of a team may easily be covered by the figure given for labor cost. The other items of cost as figured from the reports of twenty-six correspondents using one of the leading plowing tractors are given in the following table of averages. The column headed "Canada" includes reports from eleven Canadian operators of this same tractor, published by "The Canadian Thresherman and Farmer" in its annual plowing numbers from 1905 to 1909, inclusive.

TABLE V.—*Data in reference to gasoline-plowing outfits operated in the southwestern and the northwestern sections of the United States and in Canada.*

Work accomplished, etc.	Southwest.	Northwest.	Canada.	All outfits.[a]
Number of outfits	10	11	11	26
Acres plowed annually for self	479	335	....	399
Acres plowed annually for others	362	300	....	316
Acres plowed annually, total	841	635	....	715
Percentage of custom plowing	43	47	....	44
Size of engine (horsepower)	22	22	22	22
Cost of engine	$2,254	$2,300	....	$2,300
Number of plows used[b]	12	6.77	7	....
Width of furrow cut (feet)[b]	8.83	7.9	7.93	8.18
Cost of plows	$347	$244	....	$294
Hours of work each day	10.1	10.55	....	10.23
Miles covered each day	17	18.25	16.8	17
Acres covered each day	17.4	17.5	16.1	16.94
Days of plowing for the year	48	36	....	42
Men employed[c]	2	2	2	2
Labor and board (by day)[c]	$7	$7	....	$7
Quantity of fuel used each day (gallons)	53.6	49.4	[d] 50	49.2
Quantity of fuel used for each acre (gallons)	3.08	2.8	[d] 3.1	2.9
Cost of fuel for each day	$5.26	$7.31	....	$6.27
Cost of fuel for each acre	$0.302	$0.418	....	$0.37
Cost of fuel (gallon)	$0.098	$0.147	....	$0.1275
Cost of oil for each day	$0.505	$0.462	....	$0.487

[a] Data from correspondents only, including several scattered outside of the two principal sections.

[b] The figures for the Northwest are for moldboard plows and for the Southwest for disk plows; the average of all outfits includes both.

[c] Two men were reported in all but a few cases, and this number was recommended as a most satisfactory crew. No horses are included, as the reports indicate their use for only a few hours each week, if at all.

[d] United States gallons.

The following table, showing in detail the estimated cost of plowing with gasoline tractors, is based upon the foregoing averages and assumptions and should be analyzed rather than taken as a whole. Harrowing or similar work is included in 27 per cent of the cases in the Northwest and in 80 per cent in the Southwest.

Table VI.—*Acre cost of plowing with gasoline engines (including some harrowing) in the southwestern and the northwestern sections of the United States.*

Details of cost.	South-west.	North-west.	All outfits.
Interest on engine	$0.103	$0.139	$0.124
Depreciation on engine	.214	.29	.257
Repairs on engine	.10	.10	.10
Interest on plows	.023	.022	.023
Depreciation on plows	.041	.038	.041
Repairs on plows	.034	.057	.041
Interest and depreciation on miscellaneous equipment	.009	.012	.011
Labor and board	.402	.40	.413
Fuel, usually kerosene	.302	.418	.370
Oil, etc	.029	.026	.029
Total	1.257	1.502	1.409

As in the case of steam outfits, a portion of this average cost, based on the horsepower estimated to have been consumed, is chargeable to harrowing and other operations. This is ascertained to be 3 per cent in the Northwest and 11 per cent in the Southwest; consequently, the corrected acre cost of plowing only should be $1.457 and $1.119, respectively. However, no charge for the labor and cost of moving has been included, nor for labor on days when owing to bad weather or breakage no plowing was done. In most cases the crew of two men of a gasoline outfit could more easily find employment elsewhere during unfavorable weather than the larger crew of a steam outfit, and, as has been pointed out, fewer idle days from this cause are the rule, owing to the lighter weight of the engine. Perhaps one day in four would be a fair estimate of time lost from all causes. If the expenses of a 5-mile move, together with the board and a half day's wages of the two men, are allowed on each idle day, the extra expense to be borne by each day of productive labor would be from $1.75 to $2, or from 10 to 13 cents an acre, thus offsetting the reduction for harrowing.

The following table includes data furnished by operators in the Northwest on three types of gasoline tractors, distinguishing between breaking sod and plowing stubble as regards fuel consumption and acreage per day. In the case of the two-cylinder tractor the mean between breaking and plowing is given for the purpose of comparison with the figures presented in Table V.

TABLE VII.—*Comparative performance of gasoline tractors in breaking and plowing in the northwestern section of the United States.*

Details of cost, etc.	Two cylinder, 22 horsepower.[a]			Four cylinder, 30 horsepower.[b]		One cylinder, 20 horsepower.[c]	
	Breaking.	Plowing.	Mean.	Breaking.	Plowing.	Breaking.	Plowing.
Gallons of fuel used each day	51	51	51	45.1	43	24.2	26.8
Gallons of fuel used for each acre.	3.32	2.26	2.79	3.42	2.29	2.28	1.94
Average price of fuel (gallon)	$0.151	$0.141	$0.146	$0.16	$0.16	$0.16	$0.16
Cost of fuel for each day	$7.72	$7.20	$7.46	$7.24	$6.87	$3.87	$4.28
Cost of fuel for each acre	$0.512	$0.318	$0.415	$0.548	$0.366	$0.365	$0.31
Cost of labor for each day	$7	$7	$7	$7	$7	$7	$7
Cost of labor for each acre	$0.465	$0.31	$0.388	$0.53	$0.372	$0.66	$0.507
Cost of labor and fuel for each acre	$0.977	$0.628	$0.803	$1.078	$0.738	$1.025	$0.817
Cost of oil for each acre	....	....	....	$0.06	$0.043	....	....
Number of plows used	....	....	....	5.63	8.1	4.25	6
Width of furrow cut (feet)	6.52	10.14	8.33	6.57	9.45.	4.96	7
Horsepower per foot cut	3.37	2.17	2.77	4.57	3.17	4.03	2.86
Acres covered each day	15.06	22.60	18.83	13.2	18.8	10.6	13.8
Miles covered each day	19.05	18.60	18.83	16.6	16.4	17.6	16.3

[a] Number of reports received, 9. [b] Number of reports received, 15. [c] Number of reports received, 10.

The two-cylinder tractor is frequently operated with kerosene, and hence shows a lower average price per gallon of fuel. Labor is assumed at the rate of $7 a day, although this is in excess of the average reported by the majority of operators. It will be noted that the acreage in plowing is 150, 142, and 130 per cent, respectively, of that in breaking, while miles a day and the daily consumption of fuel are practically the same. The labor cost would remain the same for both kinds of work, and since the engine is usually loaded approximately the same in either case the daily figures for interest and for wear and tear would remain stationary. The variation in plow cost is so slight that for practical purposes the comparative cost of breaking and plowing can be considered as in inverse ratio to the width of furrow cut. Taking 1.4 as the ratio between the acreage in plowing and that in breaking, and assuming the daily expense to be the same in both cases, the figures shown in Table VI would indicate that without harrows attached the outfits in the Northwest break prairie at a cost of $1.70 an acre and plow in stubble at $1.214, while those in the Southwest accomplish the work at rates of $1.466 and $1.05 an acre, respectively.

COST OF PLOWING WITH HORSES.

The cost of plowing with horses under conditions obtaining on three groups of farms in southeastern, southwestern, and northwestern Minnesota, averaging, respectively, 166.9, 297.06, and 378.26 acres, is published in Bulletin No. 73, Bureau of Statistics, United States Department of Agriculture; also the cost on a single farm of 1,820 acres in northwestern Minnesota, the data from which are not included in other averages. The figures cover a period of six years, from 1902 to 1907, inclusive, and a cultivated acreage of approximately 5,000 acres a year. The average annual cost of keeping a work horse in the grain-growing section is ascertained to be $65.23 on the large farm mentioned and $75.07 on small farms averaging 378 acres each. The cost per hour of horse labor for all sections is as follows: Southeastern farms, 9.25 cents; southwestern, 8.36 cents; northwestern, 7.32 cents; on the large farm, 7.46 cents. The average annual cost given is divided by the average number of hours' work done annually by each horse and includes the following items: Interest on investment, depreciation, harness depreciation, shoeing, feed, labor, and miscellaneous expenses. On the smaller farms in the northwestern section each horse worked on an average only 3.14 hours per workday throughout the six-year period, and on the large farm somewhat less. The bulletin says:

> In order to have motive power available at seed time and harvest, the farmer is obliged to feed and house horses through seasons of practical idleness. The average annual cost of maintaining a farm work horse is approximately $80, and for this cost of maintenance the animal gives a return in work of about three hours a day throughout the year.

The cost of man labor is ascertained in the same detailed manner, the hours of both man and horse labor being a matter of daily record. The cash and labor repairs on plows are matters of careful record, and interest and depreciation are based on annual inventories. Since conditions in the northwestern part of Minnesota are like those of the grain-growing sections of the Dakotas, and especially the Red River Valley, the figures for this section are of more value in this connection than those from the southern part of the State. Including charges for man and horse labor and for plow values consumed, the cost of horse plowing in stubble land is stated in the bulletin to be as follows:[a]

Location of farms.	Fall plowing.				Spring plowing.			
	Total acres. 5 years.	Labor cost.	Plow cost.	Total cost.	Total acres. 5 years.	Labor cost.	Plow cost.	Total cost.
Southeastern Minnesota	4,773.4	$1.256	$0.086	$1.342	803.3	$1.311	$0.086	$1.397
Southwestern Minnesota	5,973.6	1.141	.132	1.273	1,413.2	1.171	.132	1.303
Northwestern Minnesota	7,186.0	1.130	.078	1.208	925.9	1.186	.078	1.264
Large farm, Minnesota	5,363.5	.924	.061	.985	526.0	.973	.061	1.034

The average cost per acre of 23,296½ acres of fall plowing was $1.201; of 3,668⅖ acres of spring plowing, $1.258; and of 26,966 acres of both fall and spring plowing, $1.209 an acre.

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[a] See Tables XXXIX and XI, Bulletin 73, Bureau of Statistics, U. S. Dept. of Agriculture.

In the northwestern group of farms 72.53 acres were broken by horses at a cost of $106.60 for labor. By adding the plow cost, the total is found to be $1.546 per acre. An earlier bulletin[a] dealing with this same investigation shows the cost of man and horse labor in breaking a small acreage in southwestern Minnesota in 1902, 1903, and 1904, to be $2.18 per acre, and the average labor cost in breaking tame sod to be $1.67 in southeastern and $1.42 in northwestern Minnesota, respectively. An average plow cost of $6\frac{4}{5}$ cents per acre should be added to these figures in comparing them with the cost shown for traction plowing. Gang plows and other large machinery are not used to any extent in the southeastern group of farms. On the large grain farm in the northwestern section the use of gang plows in large fields free from stone is shown in the reduced cost of plowing, even though the rate per hour of horse labor is higher than on smaller farms in the same neighborhood. Leaving out the plow cost, which is much greater in the case of engine gang plows, the showing is more favorable to the tractors as a source of motive power. The average cost of horse plowing will be reduced by $8\frac{9}{10}$ cents and of traction plowing from 12 cents for gasoline to 20 cents for steam by not considering the plow costs. The housing of the horses and tractors has not been considered in any of the foregoing figures, and of course this would be much cheaper in the case of tractors. Traction plowing, especially with gasoline engines, can apparently be made to approach the cost of plowing with horses if done on a large scale, but too much reliance can not be placed on the figures assumed for the depreciation of outfits. As before explained, it is impossible to present dependable averages for depreciation, owing to the recent development of the industry. On the whole it can hardly be said that traction plowing is cheaper than horse plowing, especially where horse gang plows are used, though it may be made so under favorable circumstances.

PRACTICABILITY OF TRACTION PLOWING.

No general statement as to the practicability of traction plowing can be made, as the factors involved are too many and too varied to admit of general conclusions, even for a single locality. Any one of the factors previously discussed may determine the success or failure of an outfit. Many localities are generally unsuited to the practice, but a few operators may have remarkable success because of favorable environment or unusual ability. If season, soil, and topography are favorable and fuel and water are convenient it becomes largely an individual problem. The size and cost of equipment, the acreage to be plowed, the cost of operation, the competition encountered, and the energy and ability of the operator are all important factors materially affecting any conclusions which may be drawn from averages.

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[a] Bulletin 48, Bureau of Statistics, U. S. Dept. of Agriculture, and Bulletin 97, Minnesota Agricultural Experiment Station.

Two widely varying points of view are encountered with regard to the practicability of traction plowing under any given conditions, namely, that of the landowners and that of the custom operators. The former have an interest in the crop beyond the mere cost of plowing the ground in preparation for it, and it is safe to say that the majority of these have decided the question on the basis of net returns. In many cases it was found that approximately half the number of horses kept before the purchase of a tractor were still required for such operations as drilling, harvesting, and hauling. Though in such cases the use of the engine was limited to from forty to eighty days of plowing and thrashing and the value of the horses displaced would seldom equal more than two-thirds the cost of the engine, the consensus of opinion was that the availability of power at the time when it was imperatively needed justified the added investment and cost of operation. Handling a large acreage and getting work done at any cost were first considerations with many owners of large farms, and practicability in such cases is not determined by comparisons with the cost of operation by horses, even though this is undoubtedly larger in newer sections than in those for which figures are quoted. The common rate for horse plowing in the older sections of the Dakotas is $1.50 per acre, but during rush seasons the figure has no significance, as little or no horseflesh is to be hired at such times.

For the improvement of raw land by breaking, traction outfits probably have an advantage over horses in cost of operation. Even if this were not so, the increase in value of the land due to breaking and seeding is sufficient to pay a handsome profit on every acre turned, and owners have taken advantage of this to an amazing extent. One quarter section in South Dakota, for instance, is said to have been broken this year in twenty-two hours, three steam outfits working continuously in order to accomplish the feat. A six-horse team with an ordinary gang plow would have required practically a month, Sundays included, to do the same work. After land is once broken, however, many owners consider it cheaper to plow with horses, and until the introduction of the small general-purpose motors traction-plowing outfits were most popular in newly developed areas. The cost of both horse and traction plowing will vary widely, and the averages presented do not represent the extreme possibilities of either. Many reports have been received from operators who consider traction plowing an absolute failure, and many from men who apparently have had great success with it; hence, the difficulty of approving or condemning the practice without a full knowledge of local conditions.

The operator who depends largely or wholly upon outside work is more immediately concerned with the cost of plowing than the landowner, as profits must come from the difference between the cost and the custom rate. It has been shown that of the acreage plowed by correspondents the custom-plowed area is nearly or more than equal to that plowed for the owners of the outfits. A comparatively small number do custom plowing exclusively and few outfits are maintained entirely for use on the owner's land, though the latter are said to be increasing in number with the adoption of smaller gasoline tractors. The smaller percentage of custom plowing reported by the gasoline operators also indicates that more steam outfits are kept mainly for custom plowing, and in sections where the custom rate is low it is doubtful whether any but the most successful can make a fair profit. In August, 1908, at one point in western Kansas, a local coal dealer reported that fourteen steam operators were doing custom work at the current rate of $1.25 for plowing and harrowing stubble land, and of the fourteen there was but one to whom he would extend credit on fuel. In this case competition, not with horses but between traction outfits, had forced the price per acre down to the point where if reasonably good work were done only excellent management and good luck could net a profit. The custom operator must usually pay a higher rate of wage than the farm owner, as the latter can give continuous employment during the month, while the former commonly pays his help only for days actually worked. Disabling accidents represent a total loss of time and income to the custom operator, but the farm owner is seldom wholly dependent on his engine for plowing and can make some headway without it.

The purchaser of a custom outfit assumes a considerable risk, and if ample margin between the cost and the custom rate is not to be had he invites failure in case of unfavorable circumstances. In estimating the yearly acreage required to make such a venture profitable, a separation of costs into fixed and variable items is necessary. Supposing the daily capacity of the outfit to be known, the items for fuel, labor, repairs, and oil may be reduced to a fixed acre cost. Table III indicates a total of $1.183 for these items for steam outfits in the Northwest doing both plowing and thrashing. If this figure and the ratio between the cost of breaking and that of plowing previously suggested be assumed as correct, these items would amount to $1.38 for breaking and $0.986 for plowing. Calculating interest and depreciation on engine, plows, and miscellaneous equipment as before and assuming that they will remain constant with a reasonable variation in acreage each year, the annual total chargeable to plowing would amount to approximately $486. On the basis of the 658 acres per outfit shown on a previous page the overhead charges would be 74 cents an acre. However, if it is desired only to meet the custom rates of $1.50 for plowing and $3 for breaking prevailing in parts of the Dakotas, the necessary acreage may be approximated by dividing $486 by the difference between $1.38 in one case and $3 in the other. This method gives 945 acres of plowing or 300 acres of breaking as the volume of work which will under the foregoing conditions pay operating expenses and cover interest and depreciation. This would require from sixteen to twenty days of breaking or thirty-five to forty days of plowing, without taking into account expenses on off days or in moving. Since the breaking season in this section is usually of at least six weeks' duration and the plowing season of equal length after the thrashing season, it can be seen that with good weather and management the plowing venture may be a financial success. It can not be too strongly emphasized, however, that the practicability of such a venture depends largely upon an undetermined factor, namely, the life of the outfit. The overhead charges suggested are based on an assumption in this regard that may prove to be wrong in general and certainly will not be true in every individual case. For this reason in particular the custom operator's venture is attended with considerable risk of failure, and better care than is usually given to farm machinery should be used in extending the life of a costly plowing equipment over a profitable period of service.

Granting the practicability of traction plowing under given conditions, the selection of equipment, and especially of the tractor, is a vital point. Plows for this work are in the main satisfactory and, being confined to comparatively few makes, are more easily investigated. However, the large and rapidly growing number of traction engines offered for sale makes selection difficult. To be practicable the tractor must be powerful, durable, economical, and simple, with emphasis on all four points. It must draw a profitable load continuously while at work and that without excessive depreciation and repair charges. It must be economical of fuel and labor and not so complicated as to require skill not readily acquired by the average farmer. In addition to serviceability in plowing it should be adapted to a wide range of usefulness in order to compete seriously with the horse as a source of motive power.

As to size, it may be said that for plowing alone and where work is abundant and delays few, the largest engines are the most economical, as the cost of labor and the interest and depreciation may be distributed over a larger acreage. However, the larger the outfit the longer the period of delay occasioned by wet weather and the more limited the sphere of usefulness. A larger acreage must be provided to utilize the plowing capacity of the engine, and in other work, such as thrashing, hauling, disking, harrowing, seeding, etc., frequently economical use can not be made of the power of the largest engines. The smaller engines are less economical of fuel and labor, but being better adapted to a variety of purposes reduce the overhead charges through increasing the days of service rendered.

Both steam and gasoline tractors have their advantages for this work. The former are more advanced as a class and are built in larger units, and hence are popular where conditions demand great power, as in breaking large acreages. Reference has already been made to the matter of rating engines, the steam engines as a class having a larger reserve power over the nominal rating than gasoline engines and greater tractive efficiency per nominal horsepower. On the other hand, gasoline tractors, possibly on account of size, can usually transform into effective pull a larger percentage of the power actually developed than can steam tractors. No great difference in weight per actual brake horsepower exists, but a slight advantage in favor of gasoline tractors as to weight per actual drawbar horsepower was indicated as a result of competitive tests at Winnipeg in July, 1909. Both, it may be said, were considerably below the horse in weight per unit of pulling power, and of course had a still greater advantage in driving stationary machinery. A greater weight of supplies must be carried by steam engines, this, of course, adding nothing to their strength. Gasoline engines are usually capable of longer runs without replenishing supplies, and less time is therefore lost on this account. They have the advantage in being quickly started and in not consuming fuel when not at work. The matter of supplying fuel is simpler and the expensive process of supplying water is reduced to a minimum. Internal-combustion engines as a class convert into work a much greater proportion of the thermal units in fuel than do steam engines, but present types are restricted in the kinds of fuel which can be used to advantage. Steam engines use a wide variety of fuels with little difference in efficiency and are consequently less dependent on limited sources of supply.

Aside from the foregoing considerations, the essentials are practically the same for both types. Strength must be a prime feature of a successful farm motor. This applies particularly to frame and traction gearing. The latter should be of steel or semisteel, wide in face and bearing, and of the best workmanship. The gearing should be absolutely protected from dust, as should all bearing surfaces. The gears probably more than any other parts are subject to wear and breakage and should receive great attention from both manufacturers and purchasers. They should be in perfect alignment at all times to prevent unequal wear, followed by strain and breakage. Rigidity of frame and wide bearings tend to effect this alignment, yet in so far as is possible flexibility should be allowed in order to minimize the effect of rough ground. Jolting should be transmitted as little as possible to moving parts mounted on the boiler frame. Perfect lubrication is necessary, and all parts of the engine should be easily and instantly accessible for repairs or adjustment.

The traction wheel is a fundamental point. One authority states that in building a tractor he would first build the wheel and then the engine. The wheel must be either wide enough or high enough to support the weight of the engine on soft ground and to distribute it under all circumstances without undue packing of the soil. Some tractors already rival the horse in the matter of weight per unit of bearing surface. Besides width and height there must be a proper arrangement of lugs on the surface of the wheel in order that it may grip the soil firmly and still not clog. Great loss of power may occur in this simple point of application. Types of wheel composed of independent pedals are being developed, with a view to reducing the loss through slippage.

In general it may be said that the progress made in the last six years in the development of both steam and gasoline tractors has been remarkable and that the concentration of capital and thought upon the problem of supplying practicable farm motors gives promise of even more rapid progress in the next decade. When it is considered that during the long era of development of farm machinery no radical improvement has been effected in the animal as a source of motive power, it is not surprising that the early history of plowing by mechanical prime movers does not show a general advantage in economy over ordinary methods. The animal as a motor has many advantages which must be overcome before the universal introduction of mechanical substitutes, and the latter is not imminent. However, the increasing purchase and use of smaller tractors by western farmers, not only in grain-growing sections but on larger farms in the corn belt, indicate that practical men are finding profitable employment for a general-purpose farm engine. So long as large areas of prairie remain to be broken there will be a field for the large plowing engine developed for that purpose alone, but the activity displayed by inventors and manufacturers justifies the expectation of dependable farm motors, varying in type and size, adapted to a much greater variety of work than that in which they have hitherto been chiefly employed.

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